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NASA

Technology for Large Space Systems

A Bibliography
with Indexes

NASA SP-7046(06)
January 1982

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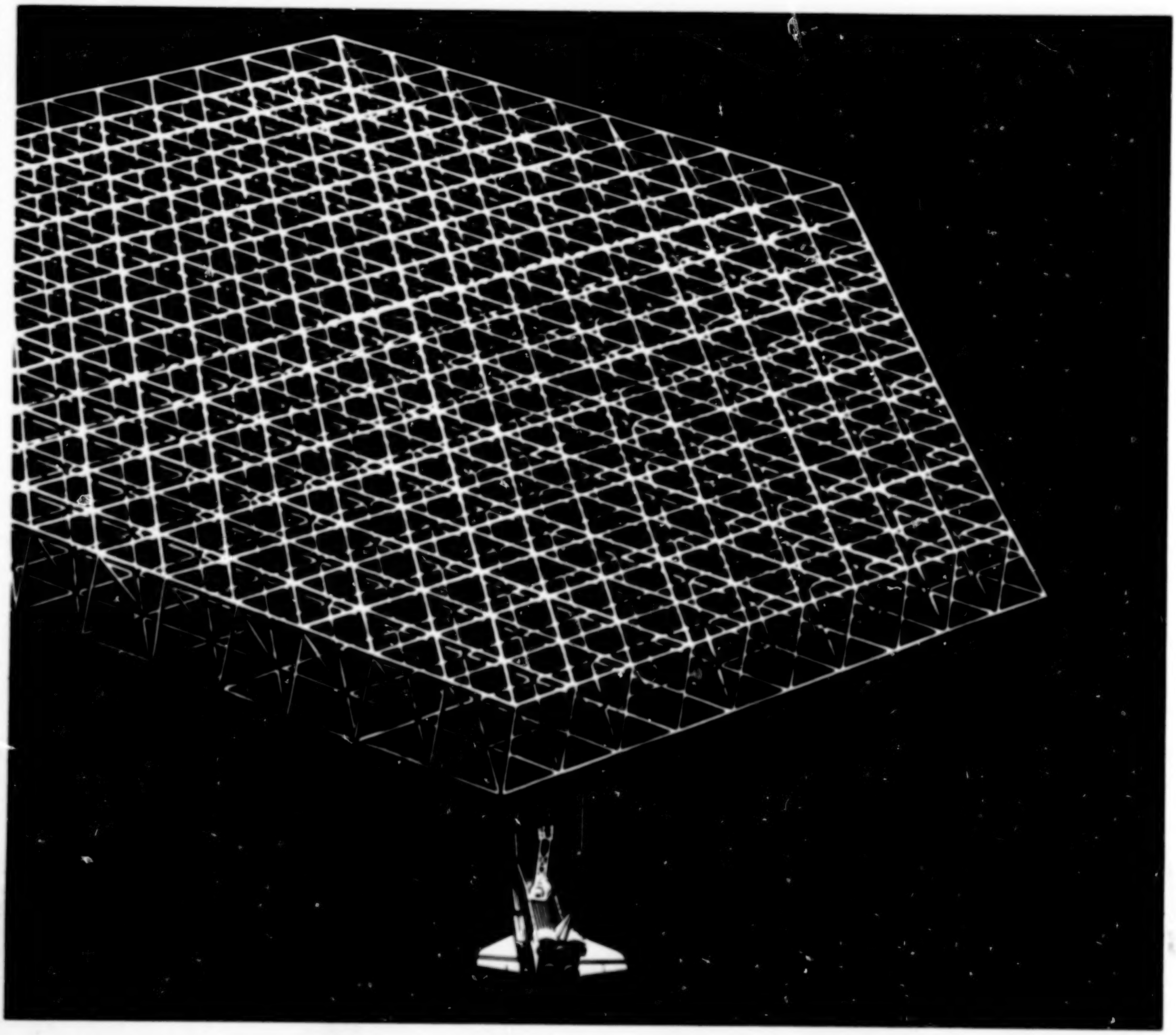

NASA SP-7046(06)

TECHNOLOGY FOR LARGE SPACE SYSTEMS

A SPECIAL BIBLIOGRAPHY WITH INDEXES

Supplement 6

A selection of annotated references to unclassified reports and journal articles that were introduced into the NASA scientific and technical information system between July 1 and December 31, 1981 in

- *Scientific and Technical Aerospace Reports (STAR)*
- *International Aerospace Abstracts (IAA).*

NASA Scientific and Technical Information Branch 1982
National Aeronautics and Space Administration
Washington, DC

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NOTE TO AUTHORS OF PROSPECTIVE ENTRIES:

The compilation of this bibliography results from a complete search of the *STAR* and *IAA* files. Many times a report or article is not identified because either the title, abstract, or key words did not contain appropriate words for the search. A number of words are used, but to best insure that your work is included in the bibliography, use the words *Large Space Structures* somewhere in your title or abstract, or include them as a key word.

This supplement is available from the National Technical Information Service (NTIS), Springfield, Virginia 22161 at the price code A04 ($9.00 domestic; $18.00 foreign).

INTRODUCTION

This special bibliography is designed to be helpful to the researcher and manager engaged in developing technology within the discipline areas of the Large Space Systems Technology (LSST) Program. Also, the designers of large space systems for approved missions (in the future) will utilize the technology described in the documents referenced herein.

This literature survey lists 220 reports, articles and other documents announced between July 1, 1981 and December 31, 1981 in *Scientific and Technical Aerospace Reports (STAR)*, and *International Aerospace Abstracts (IAA)*.

The coverage includes documents that define specific missions that will require large space structures to achieve their objectives. The methods of integrating advanced technology into system configurations and ascertaining the resulting capabilities is also addressed.

A wide range of structural concepts are identified. These include erectable structures which are earth fabricated and space assembled, deployable platforms and deployable antennas which are fabricated, assembled, and packaged on Earth with automatic deployment in space, and space fabricated structures which use pre-processed materials to build the structure in orbit.

The supportive technology that is necessary for full utilization of these concepts is also included. These technologies are identified as analysis and design, structural dynamics and control, electronics, advanced materials, assembly concepts, and propulsion.

A Flight Experiments category and a General category complete the list of subjects addressed by this document.

The selected items are grouped into ten categories as listed in the Table of Contents with notes regarding the scope of each category. These categories were especially selected for this publication and differ from those normally found in *STAR* and *IAA*.

Each entry consists of a standard bibliographic citation accompanied by an abstract where available, and appears with the original accession numbers from the respective announcement journals.

Under each of the ten categories, the entries are presented in one of two groups that appear in the following order:

1) *IAA* entries identified by accession number series A81-10,000 in ascending accession number order;
2) *STAR* entries identified by accession number series N81-10,000 in ascending accession number order.

After the abstract section there are five indexes - subject, personal author, corporate source, contract number, and report/accession number.

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All publications abstracted in this Section are available from the Technical Information Service, American Institute of Aeronautics and Astronautics, Inc. (AIAA), as follows: Paper copies of accessions are available at $8.00 per document. Microfiche(1) of documents announced in *IAA* are available at the rate of $4.00 per microfiche on demand, and at the rate of $1.35 per microfiche for standing orders for all *IAA* microfiche.

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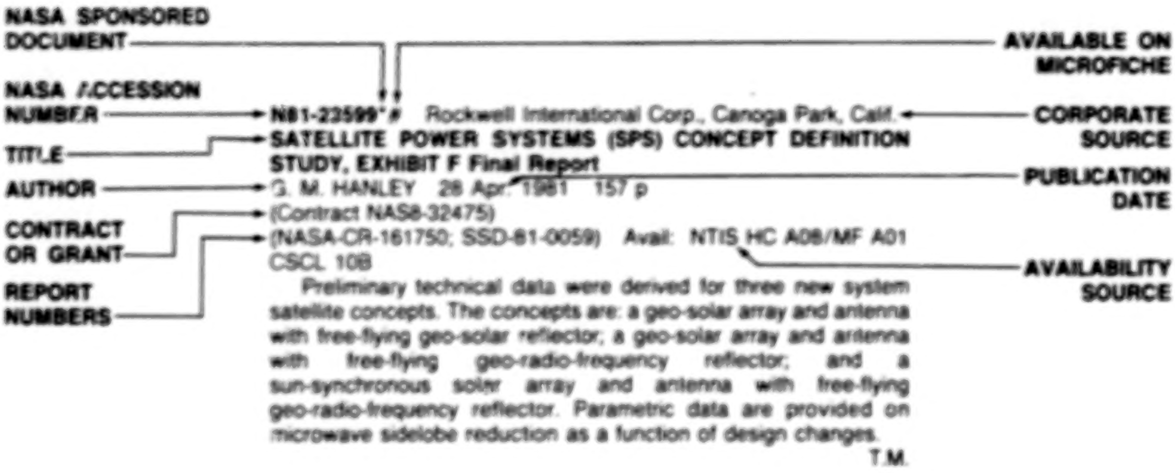
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N81-23599*# Rockwell International Corp., Canoga Park, Calif.
SATELLITE POWER SYSTEMS (SPS) CONCEPT DEFINITION STUDY, EXHIBIT F Final Report
G. M. HANLEY 28 Apr. 1981 157 p
(Contract NAS8-32475)
(NASA-CR-161750; SSD-81-0059) Avail: NTIS HC A08/MF A01 CSCL 10B

Preliminary technical data were derived for three new system satellite concepts. The concepts are: a geo-solar array and antenna with free-flying geo-solar reflector; a geo-solar array and antenna with free-flying geo-radio-frequency reflector; and a sun-synchronous solar array and antenna with free-flying geo-radio-frequency reflector. Parametric data are provided on microwave sidelobe reduction as a function of design changes. T.M.

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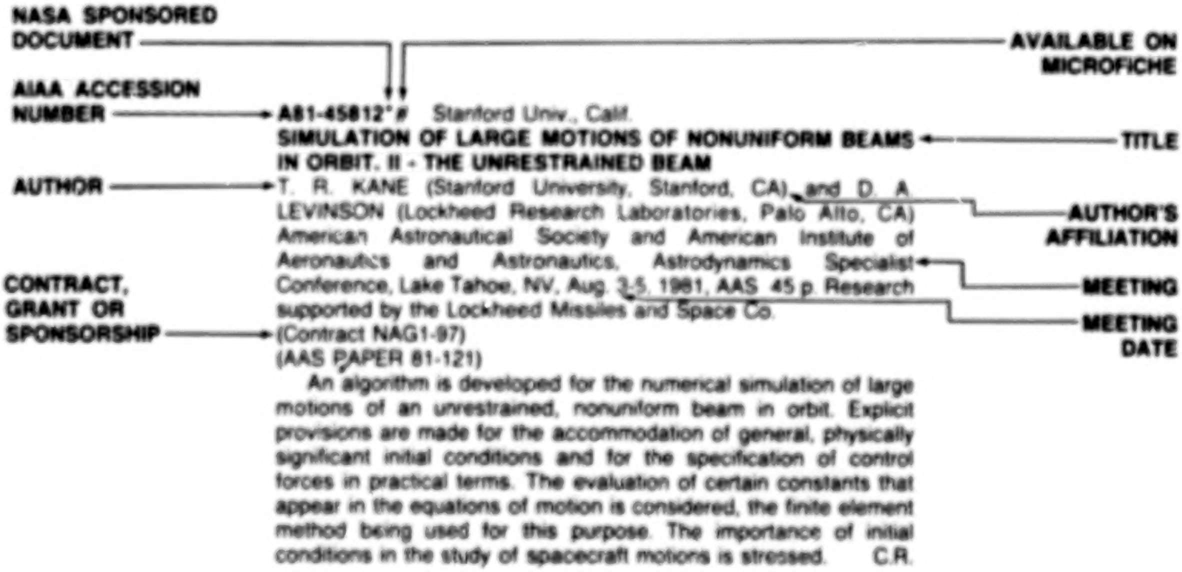
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A81-45812*# Stanford Univ., Calif.
SIMULATION OF LARGE MOTIONS OF NONUNIFORM BEAMS IN ORBIT. II - THE UNRESTRAINED BEAM
T. R. KANE (Stanford University, Stanford, CA) and D. A. LEVINSON (Lockheed Research Laboratories, Palo Alto, CA) American Astronautical Society and American Institute of Aeronautics and Astronautics, Astrodynamics Specialist Conference, Lake Tahoe, NV, Aug. 3-5, 1981, AAS 45 p. Research supported by the Lockheed Missiles and Space Co.
(Contract NAG1-97)
(AAS PAPER 81-121)

An algorithm is developed for the numerical simulation of large motions of an unrestrained, nonuniform beam in orbit. Explicit provisions are made for the accommodation of general, physically significant initial conditions and for the specification of control forces in practical terms. The evaluation of certain constants that appear in the equations of motion is considered, the finite element method being used for this purpose. The importance of initial conditions in the study of spacecraft motions is stressed. C.R.

TECHNOLOGY FOR LARGE SPACE SYSTEMS

A Special Bibliography (Suppl. 6)

JANUARY 1982

01

SYSTEMS

Includes mission and program concepts and requirements, focus missions, conceptual studies, technology planning, and systems analysis and integration.

A81-30645

ON THE COMPOSITION AND DEVELOPMENT OF A SPACE-BASED INTERSTELLAR SEARCH SYSTEM

W. STUIVER (Hawaii, University, Honolulu, Hawaii), D. SOUTHWOOD, and F. ENOMOTO (Stanford University, Stanford, Calif.) British Interplanetary Society, Journal (Interstellar Studies), vol. 34, June 1981, p. 247-250. refs

A definition of the mission parameters and structural configurations is presented for space-based antenna systems of very large receiver aperture to be used for the search of signals from extraterrestrial intelligence. It is suggested that the collinear transterrestrial libration point of the sun-earth system is the ideal operational location for orbiting radio-telescopes; this idea is based on the observation that the transterrestrial libration point represents the nearest location in the solar system at which the number of major components required for a satisfactory operation of such radiotelescopes may be reduced to two. Fabrication and assembly of the major components of space-based antenna systems, to be built around the turn of the century, would probably take place in geostationary orbit. A feasibility study of solar sailing transfer of these components from geosynchronous altitude to the transterrestrial libration point has been initiated. Estimates of component area-to-mass ratios have been established, and it was shown, by means of a mathematical model of the transfer problem, that utilization of solar radiation for the purpose of reaching the preferred operational location from the geosynchronous altitude may be possible. K.S.

A81-32294

THE DESIGN OF COMMUNICATIONS SYSTEMS ON LARGE SPACE PLATFORMS

E. KATZ and R. DONAVAN (Rockwell International Corp., Space Systems Group, Downey, Calif.) In: ICC '80; International Conference on Communications, Seattle, Wash., June 8-12, 1980, Conference Record. Volume 1. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 9.4.1-9.4.4.

Several design concepts and requirements for communications payloads are described that differ significantly from current design. New features include less stringent mass and volume limitations; independent parts for installation, servicing, and removal; a stable base; access to ground stations through independent command and telemetry channels; power and connections to other payloads; payload checkout at LEO before transfer to GEO; and lower cost. New requirements are also imposed: (1) each payload must convert and regulate main bus power; (2) high-gain antennas will require autotracking; (3) payload dynamics must be decoupled from platform control and structural dynamics; and (4) the payload must be designed for GEO installation, deployment, and replacement as well as LEO installation. Plug-in modular design is necessary for payload maintenance and exchange. B.J.

A81-32520*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

SPACE PLATFORMS FOR SCIENCE AND APPLICATIONS

W. C. SNODDY (NASA, Marshall Space Flight Center, Huntsville, Ala.) Astronautics and Aeronautics, vol. 19, Apr. 1981, p. 28-36. refs

It is pointed out that space platforms offer a flexible and cost-effective evolutionary approach to conducting science and applications missions of several months' duration and can pave the way for major manned orbital facilities. General-purpose Low-Earth-Orbit space platforms are made possible by the Space Transportation System. Such platforms could remain in orbit for many years serviced as needed by the Shuttle. Attention is given to a Power System Platform, aspects of communications and data handling, stability and control, system and subsystem capability, a dynamics-analysis model of an expanded platform, command and data flow for a space platform, comparative costs of flying a pallet-size payload, a continually mannable Science and Applications Manned Space Platform, and a scenario of how the space platform might evolve. G.R.

A81-33547#

SPACE CONSTRUCTION OF LARGE STRUCTURES - BEYOND WHAT SIZES SHOULD YOU WANT TO SPACE-FABRICATE RATHER THAN ERECT OR DEPLOY

E. KATZ and H. MYERS (Rockwell International Corp., Pittsburgh, Pa.) American Astronautical Society and American Institute of Aeronautics and Astronautics, Annual Meeting on Space Enhancing Technological Leadership, Boston, Mass., Oct. 20-23, 1980, AAS 7 p. refs
(AAS PAPER 80-277)

Examples will be cited from prior studies of various sizes and applications of space-fabricated structures. Each will be considered in the light of the following criteria: (1) packaging in the orbiter's cargo bay; (2) operations required to construct; (3) requirements for construction support equipment; (4) compatibility with the installation of systems (e.g., lines and components); and (5) technology requirements and program confidence levels. Using these same criteria, observations will be given on the relative merits of 'comparable' erected and deployed systems, using prior study results where available. The end product of this paper is the identification of those size and application categories where space-fabrication is probably advantageous and those categories where it is probably not competitive. In addition, the paper will highlight those categories where the choice is unclear and identify the key questions affecting the outcome. (Author)

01 SYSTEMS

A81-34752

DESIGN PROBLEMS OF LARGE SPACE MIRROR RADIOTELESCOPES

A. S. GVAMICHAVA, V. I. BUIAKAS, N. S. KARDASHEV, N. P. MELNIKOV, A. S. SOKOLOV, G. S. TSAREVSKII, and V. I. USIUKIN (Akademiia Nauk SSSR, Institut Kosmicheskikh Issledovanii and Sovet po Mezhdunarodnomu Sotrudnichestvu v Oblasti Issledovaniia i Ispol'zovaniia Kosmicheskogo Prostranstva Interkosmos, Moscow, USSR) (International Astronautical Federation, International Astronautical Congress, 30th, Munich, West Germany, Sept. 17-22, 1979.) Acta Astronautica, vol. 8, Apr. 1981, p. 337-348. refs

It is noted that large space antennas can solve problems of theoretical and practical importance. Large-diameter (tens or hundreds of meters) mirror antennas have been designed to use an automatically deployed truss frame as a base onto which the radio-reflecting surface is pulled (long-wave version) or on which controllable panels are mounted (short-wave version). The reasons why antennas of mm range can be promptly developed are discussed. Consideration is given to the factors that influence the precision of the reflecting surface of the space antenna, that is technological errors during the process of frame manufacture, technological errors during the manufacture of the reflecting surface, and deformation arising from thermal or force effects. The need to design antennas with automatic control of the reflecting surface in order to operate in the mm wavelength range is stressed. C.R.

A81-36434#

SPACE INFORMATION STATIONS - TECHNOLOGICAL AND INSTITUTIONAL ASPECTS

D. D. SMITH (Communications Satellite Corp., Washington, D.C.) In: Colloquium on The Law of Outer Space, 23rd, Tokyo, Japan, September 21-28, 1980, Proceedings. New York, American Institute of Aeronautics and Astronautics, Inc., 1981, p. 197-200.

Space information stations are defined as large structures constructed in outer space in order to provide for the gathering, processing, transmission, and dissemination of information for relatively long periods of time. The replacement of conventional communications satellites with space information stations is justified because the stations will conserve spectrum and geostationary resources, provide lower service rates and equipment costs due to economies of scale, and dramatically increase the variety of space communications and applications services. However, the legal and institutional relationships between owners, managers and users of such stations pose difficult problems which may result in a delay in the development of such stations. An institutional configuration based on independent ownership of component parts of such stations is described and offered as a solution to the problems. Moreover, a set of international norms is offered which could also help solve institutional problems. (Author)

A81-37733* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

A LARGE-APERTURE SPACE TELESCOPE FOR INFRARED AND SUBMILLIMETER ASTRONOMY

J. P. MURPHY, M. K. KIYA, M. WERNER (NASA, Ames Research Center, Moffett Field, CA), P. N. SWANSON, T. B. H. KUIPER, and P. D. BATELAAN (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) In: Active optical devices and applications; Proceedings of the Seminar, Washington, DC, April 10, 11, 1980. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1980, p. 117-127. refs

The Large Aperture Telescope (LAT), which will have a diameter of 10-30 m and will operate in the 2-1000 micron wavelength range, is described. It is noted that the LAT could be carried into orbit with a single launch of the Space Transportation System and semiautomatically deployed as a free flyer with a nominal 10-yr mission duration. Servicing and instrument changes would be made at 2-yr intervals. It is pointed out that the LAT would have to be placed above the earth's atmosphere to avoid both the absorption that occurs through much of the infrared and submillimeter and the turbulence which limits spatial resolution. Important technical considerations for the LAT are discussed; they include the telescope optical form, the primary mirror material, figure control techniques, the deployment techniques, and thermal control. The science objectives and rationale for the LAT are discussed and various hardware techniques and concepts for its implementation are described. C.R.

A81-41197#

THE LARGE SATELLITE PROGRAM OF ESA AND ITS RELEVANCE FOR BROADCAST MISSIONS

H.-H. FROMM and B. L. HERDAN (ESA, Communications Satellites Dept., Noordwijk, Netherlands) (Canadian Aeronautics and Space Institute, Canadian Conference on Astronautics, 1st, Ottawa, Canada, Oct. 20-22, 1980.) Canadian Aeronautics and Space Journal, vol. 27, 1st Quarter, 1981, p. 11-16.

In an investigation of the market prospects and payload requirements of future communications satellites, it was concluded that during the next 15 years many space missions will demand larger satellite platforms than those currently available. These platforms will be needed in connection with direct-broadcasting satellites, satellites required to enhance capacities in the case of traditional services, and satellites employed to introduce new types of satellite-based communications operating with small terminals. Most of the larger satellites would require the Ariane III capability, corresponding to about 1400 kg satellite mass in geostationary orbit. Attention is given to L-SAT platform capabilities and broadcast payload requirements, taking into account a European direct-broadcast satellite and Canadian direct-broadcast missions. G.R.

A81-41801

REFLECTOR SATELLITES FOR SOLAR POWER

T. F. ROGERS IEEE Spectrum, vol. 18, July 1981, p. 38-43. refs

A global photovoltaic power distribution system is conceptualized in the paper. GW sized solar cell arrays constructed in sunny, arid regions of the world would convert sunlight to dc, dc to microwaves in mm length, then beam the power to passively reflecting geostationary satellites, which in turn redirect the beams to rectennas on the earth for reconversion to dc for immediate use or adjustment to ac and transmission. The system is projected to have lower costs for space equipment than SPS because the cells would be based earth-side, and could be constructed in areas where the populations are poorest and land is least valuable. Cost estimates are in the range of $20 billion for 10,000 sq km collectors and converters and a 600 sq mm reflector in orbit. A global distribution of the photovoltaic clusters would provide base-load electricity because some areas would always be in sunlight. Techniques for compensation for atmospheric attenuation are reviewed, noting a final system efficiency of 1-8% is attainable, with costs similar to those now associated with fusion power development. D.H.K.

A81-42105#

ANTENNAS FOR COMMUNICATIONS SATELLITES

H. RIEGER and B. ABT Dornier-Post (English Edition), no. 2, 1981, p. 23-26.

The design and objectives of West Germany's TV-SAT are discussed. The mechanical antenna concept for the satellite is examined; attention is given to the antenna components, its pointing and folding mechanisms, and the carbon fiber-reinforced plastic used to fabricate the antenna. The development status of the TV-SAT antenna is reviewed. It is noted that, in development tests, the reflection losses have been about 0.05 dB at 12 GHz and 0.07 dB at 18 GHz (depending on the fiber orientation), the cross-polarization distance has been better than -45 dB, and the radiation diagram has shown excellent symmetry at low side lobes. F.G.M.

A81-42516

SPACE SHUTTLE AND SOLAR POWER SATELLITE SYSTEMS

G. M. HANLEY (Rockwell International Corp., Pittsburgh, PA) In: Update on space. Volume 1. Granada Hills, CA, National Behavior Systems, 1981, p. 106-125.

The most significant fact about the Shuttle is that it makes it possible to place men and materials into orbit in a routine manner. Solar power satellites use solar cells to convert solar energy on orbit into electrical energy which is transmitted down to the ground using radio frequency waves which are received by a ground antenna and turned into direct current electrical energy. The satellite is in geosynchronous orbit. At this altitude sunlight is present approximately 99% of the time. A typical satellite is roughly 10 miles long and about 2-1/2 miles wide. It is assembled on orbit, with the materials brought up from earth. Each satellite produces 5 gigawatts of power. Plans are to start construction on solar power satellites around the year 2000. Energy-providing space systems which have been rejected after an evaluation include a nuclear reactor in space and a solar thermal system. The selected photovoltaic system will possibly use gallium aluminum arsenide cells instead of silicon cells. Attention is also given to problems of microwave energy transmission, details of satellite construction, and aspects of cost. G.R.

A81-43135#

KINEMATIC APPLICATIONS UTILIZING STORAGE TUBE GRAPHICS

R. L. TENNISON (Vought Corp., Dallas, TX) American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Dayton, OH, Aug. 11-13, 1981, 7 p.
(AIAA PAPER 81-1628)

Three different examples will be given to illustrate how a graphics system may be utilized for analysis of kinematic problems encountered in engineering design: (1) an analysis of the clearance involved in the movement of a clam-shell thrust reverser, (2) a graphic illustration of the motion involved in the folding-unfolding of a space platform, (3) a display of the results of a mathematical study of the Eccentuator. These three studies were made on a commercial turn-key mini-system using a high-level graphics programming language. (Author)

A81-44397

HIGH PRECISION GRAPHITE/EPOXY ANTENNAS FOR COMMUNICATIONS SATELLITES

B. ABT and H. RIEGER (Dornier System GmbH, Friedrichshafen, West Germany) In: Material and process applications - Land, sea, air, space; Proceedings of the Twenty-sixth National Symposium and Exhibition, Los Angeles, CA, April 28-30, 1981. Azusa, CA, Society for the Advancement of Material and Process Engineering, 1981, p. 848-860.

This paper deals with the development, manufacture and test of a precision graphite/epoxy antenna structure (reflector and tower), a program that was performed in view of the German direct-to-home TV broadcasting satellite. The TV-SAT has two deployable antennas of the same type as described, mounted to a common tower. The reflectors are sandwich shell construction supported by tubular frameworks. Ultra high modulus carbon fibres are used for the skins yielding a high thermal stability and structural stiffness, and in particular this design does not require an additional metallic coating, even for an application beyond 18 GHz. High precision tooling equipment assures best contour quality. The thermal control design is passive using thermal tape for the framework, and depending on the spacecraft concept, thermal coating of the dish may be required or not. Data of the reflectors mechanical, thermal, and electrical performances are given. In parallel to the reflector a thermally stable CFRP antenna tower truss consisting of filament wound tubes has been developed. (Author)

A81-44848*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

SOLAR SAIL ENGINEERING DEVELOPMENT MISSION

H. W. PRICE (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) AIAA Student Journal, vol. 19, Summer 1981, p. 14-18, 42. Research sponsored by the World Space Foundation and NASA. refs.

Since photons have momentum, a useful force can be obtained by reflecting sunlight off of a large, low mass surface (most likely a very thin metal-coated plastic film) and robbing the light of some of its momentum. A solar sail Engineering Development Mission (EDM) is currently being planned by the World Space Foundation for the purpose of demonstrating and evaluating solar sailing technology and to gain experience in the design and operation of a spacecraft propelled by sunlight. The present plan is for the EDM spacecraft to be launched (sail stowed) in a spin-stabilized configuration into an initial elliptical orbit with an apogee of 36,000 km and a perigee of a few hundred kilometers. The spacecraft will then use its own chemical propulsion system to raise the perigee to at least 1,200 km. The deployed sail will have an area of 880 sq m and generate a solar force of about 0.007 N. G.R.

A81-47305

THE ITALIAN PARTICIPATION TO THE TETHERED SATELLITE SYSTEM

G. COLOMBO, S. BERGAMASCHI (Padova, Universita, Padua, Italy), and F. BEVILACQUA (Aeritalia S.p.A., Naples, Italy) International Astronautical Federation, International Astronautical Congress, 32nd, Rome, Italy, Sept. 6-12, 1981, 19 p.
(IAF PAPER 81-33)

The Tethered Satellite System (TSS), a device whereby measurement platforms and other objects can be deployed by means of a connecting tether to station points as far as 100 km from the Space Shuttle, is discussed. In connection with the agreement between the U.S. and Italy, it is noted that NASA will be responsible for the design and development of the deployer and CNR will be responsible for the design and development of the subsatellite. Scientific applications of the TSS include those which use the tether as a means of carrying instrumentation to a suitable distance from the Shuttle and those which use the tether as a part of the instrumentation. Among the low-altitude scientific applications are studies of the earth's magnetic and gravitational fields, aeronomy, research on the problem of re-entry, earth observations, and plasma physics. The technological applications of the TSS are those in which the tether is used as a structure or a crane C.R.

A81-47311* National Aeronautics and Space Administration, Washington, D. C.

GEOSTATIONARY MULTIPURPOSE PLATFORMS

I. BEKEY (NASA, Washington, DC) and R. M. BOWMAN (General Dynamics Corp., Convair Div., San Diego, CA) International Astronautical Federation, International Astronautical Congress, 32nd, Rome, Italy, Sept. 6-12, 1981, 35 p.
(IAF PAPER 81-45)

In addition to the advantages generally associated with orbital platforms, such as improved reliability, economies of scale, simple connectivity of elements, reduced tracking demands and the restraint of orbital object population growth, geostationary platforms yield: (1) continuous access by fixed ground antennas for communications services; (2) continuous monitoring of phenomena over chosen regions of the earth's surface; (3) a preferred location for many solar-terrestrial physics experiments. The geostationary platform also offers a low-risk and economical solution to the impending saturation of the orbital arc/frequency spectrum, maximizing the capacity of individual slots and increasing the utility of the entire arc. It also allows the use of many small, simple and inexpensive earth stations through complexity inversion and high power per beam. Block diagram and operational flowcharts are provided. O.C.

A81-47313

A NUCLEAR WASTE DEPOT AS A LARGE PLATFORM IN EARTH ORBIT

H. O. RUPPE and D. HAYN (Muenchen, Technische Universitaet, Munich, West Germany) International Astronautical Federation, International Astronautical Congress, 32nd, Rome, Italy, Sept. 6-12, 1981, 15 p. refs

(IAF PAPER 81-47)

The storing and disposal of high-activity nuclear wastes (HAW) in large structures at high earth orbit is considered to the end of the century and beyond. Among the topics discussed are: (1) the rate of accumulation of HAW on earth and at the space disposal station; (2) the projected growth of those rates of accumulation; (3) HAW payload launch schemes; (4) alternative nuclear waste disposal platform configurations; (5) lifetime mapping of long-lifetime orbits based on the 11-year mean solar cycle; and (6) the ultimate destination of nuclear waste disposal platforms. It is concluded that the additional cost to nuclear electricity consumers incurred by the implementation of a 1000-km altitude orbit platform scheme is 0.04 cents/kWh(e). The concept of the mass-driver is briefly covered, and various statistics concerning nuclear waste loads are given. O.C.

A81-47314

THE SOLARIS PROGRAM

J. J. RUNAVOT (Centre National d'Etudes Spatiales, Toulouse, France) and F. DURET (Societe Nationale Industrielle Aerospatiale, Les Mureaux, Yvelines, France) International Astronautical Federation, International Astronautical Congress, 32nd, Rome, Italy, Sept. 6-12, 1981, 10 p.

(IAF PAPER 81-49)

The Ariane-launched, automated Solaris satellite system for validation of key technologies to be used in future low- and geosynchronous-orbit missions is described. The main purpose of the project is the development of a space materials processing capability, and as presently envisioned comprises a service module which provides all support functions and a partially recoverable automated vehicle for rendezvous, docking and re-entry. The service module will produce 10 kW of electricity, a data transmission capacity of up to several hundreds of MB/sec, and the possibility of complex mechanical interventions through an automated manipulation system. The tentative launch date for the system is in the 1991-4 period, and it is expected to have a functional lifetime of some 15 years. O.C.

A81-47317

GLOBAL SATELLITE COMMUNICATIONS SYSTEM USING GEOSTATIONARY PLATFORMS

W. F. RECTOR, III and R. M. BOWMAN (General Dynamics Corp., Convair Div., San Diego, CA) International Astronautical Federation, International Astronautical Congress, 32nd, Rome, Italy, Sept. 6-12, 1981, 41 p.

(IAF PAPER 81-52)

A proposed system of six geostationary platforms able to meet the entire point-to-point communication requirements of the year 2000 is discussed. The system will furnish mobile, maritime, and direct broadcast services at reasonable cost to any of the six geographic regions defined. Such a scheme would leave the rest of the geostationary arc for conventional broadcast satellites, as well as the growth of new systems. The platforms would be deployed in pairs over the Pacific, Atlantic and Indian oceans, and would be connected with inter-spacecraft links to provide single-hop global service. It is stipulated that each platform should be able to grow over the course of its lifetime, additional payload modules being added to meet increasing demand. O.C.

A81-47321

LARGE PLATFORMS FOR FUTURE TELECOMMUNICATION APPLICATIONS - EUROPEAN CONCEPTUAL APPROACH

F. BEVILACQUA and M. PASTA (Aeritalia S.p.A., Turin, Italy) International Astronautical Federation, International Astronautical Congress, 32nd, Rome, Italy, Sept. 6-12, 1981, 16 p.

(IAF PAPER 81-57)

The results of a conceptual study considering the character of low earth orbit-assembled geostationary telecommunications platforms, that are to be ferried by the Space Shuttle, are presented; with emphasis on the mass and power requirements of payloads stipulated by the ESA. Two platform configurations are proposed, one of which is the assumed baseline and has a single Shuttle flight requirement. Both configurations are modular and allow a wide variety of payload arrangements. Details are also provided for the baseline configuration at the subsystem level, covering chemical and electrical propulsion, attitude and orbit control, structure, thermal control and power requirements. Roles for such a platform configuration, serving as an interim system between present satellites and future space stations, are also identified. O.C.

A81-47328

THE EUROPEAN LARGE TELECOMMUNICATION SATELLITE /L-SAT/ PROGRAMME - DEMONSTRATION MISSION AND FUTURE PERSPECTIVES

B. L. HERDAN (ESA, Directorate of Application Satellites Programmes, Noordwijk, Netherlands) International Astronautical Federation, International Astronautical Congress, 32nd, Rome, Italy, Sept. 6-12, 1981, 22 p.

(IAF PAPER 81-68)

The main objectives of the European Space Agency Large Telecommunications Satellite (L-SAT) program are: (1) the development of a multi-purpose platform matched to a range of future mission needs; (2) the development of a multi-element advanced communications payload; and (3) the launch of a single flight model carrying the payload to support a range of communications missions. The main features of the L-SAT design include a solar array power of 3300 W, an eclipse power capacity of 1050 W, and a total dry mass of 1244 Kg; payload characteristics consist of a north and south radiating area of 9 sq m, a core body size of minimum dimensions (1.75 m x 2.1 m x 3.5 m), and the capability of mounting antennas from the east and west faces of the body. Four demonstration missions to be supported by the first flight are discussed in detail: the broadcast mission, the specialized services mission, the 20/30 GHz communications mission, and the 12/20/30 GHz propagation package. A summary of the program status and perspectives for future L-SAT derivatives are given. Maps, diagrams, and charts accompany the data. J.F.

A81-47336

L-SAT - A NEW EXAMPLE OF EUROPEAN AND TRANSATLANTIC INDUSTRIAL COOPERATION

L. BLONSTEIN (British Aerospace Public, Ltd., Co., Space and Communications Div., Stevenage, Herts., England) International Astronautical Federation, International Astronautical Congress, 32nd, Rome, Italy, Sept. 6-12, 1981, 13 p.

(IAF PAPER 81-77)

The formation of the industrial teams established to develop the early ESA telecommunications programs is described. Attention is also given to the way in which the teams have changed as new programs have materialized, leading to the changes in emphasis dictated by the new international relationships in the L-Sat program. The satellites discussed are the Orbital Test Satellite (OTS), the European Communications Satellite (ECS), the Maritime ECS, and the Large European Satellite. The principal European contractors in the OTS program are listed, as are the U.S. suppliers in the OTS program, the principal suppliers in the ECS program, the principal suppliers in the MARECS program, and the principal system contractors in the L-Sat program. C.R.

A81-47416
THE ECONOMICS OF LARGE ORBITAL COMMUNICATIONS SYSTEMS
W. L. MORGAN (Clarksburg, Communications Center, Clarksburg, MD) International Astronautical Federation, International Astronautical Congress, 32nd, Rome, Italy, Sept. 6-12, 1981, 9 p. (IAF PAPER 81-226)

This paper looks at the economics of a very large satellite in geostationary orbit. Using present-day charges for satellite transponders, it is shown that the seemingly high cost of this type of platform is rapidly repaid. Several orbit locations are selected on the basis of current usage and a satellite is configured. The power and mass requirements are identified. Cost histories of both satellites and launch vehicles were established using current programs. This information is used to extrapolate the total space segment of a large platform. It is shown that the original investment is repaid in less than three years. After this time the platform continues to earn revenue for its operators. (Author)

N81-22073*# National Aeronautics and Space Administration, Washington, D. C.
SOLARIS: ORBITAL STATION: AUTOMATIC LABORATORY FOR OUTER SPACE RENDEZVOUS AND OPERATIONS
J. J. RUNAVOT Apr. 1981 31 p Transl. into ENGLISH of "Solaris Station Orbitale - Laboratoire Automatique pour le Rendezvous et les Interventions Spatiales" Rept. Centre Nationale d'Etudes Spatiales, Centre Spatiale de Toulouse (France), Toulouse, 10 Sep. 1980 p 1-27 Transl. by Kanner (Leo) Associates, Redwood City, Calif. Original doc. prep. by Centre Spatial de Toulouse
(Contract NASW-3199)
(NASA-TM-76403) Avail: NTIS HC A03/MF A01 CSCL 22B

The preliminary design for a modular orbital space station (unmanned) is outlined. The three main components are a support module, an experiment module, and an orbital transport vehicle. The major types of missions (assembly, materials processing, and Earth observation) that could be performed are discussed. Author

N81-22469*# Rockwell International Corp., Downey, Calif. Space Operations and Satellite Systems Div.
SATELLITE POWER SYSTEMS (SPS) CONCEPT DEFINITION STUDY (EXHIBIT D). VOLUME 5: SYSTEMS ENGINEERING/INTEGRATION RESEARCH AND TECHNOLOGY Final Report
G. M. HANLEY Washington NASA Mar. 1981 216 p refs 7 Vol.
(Contract NAS8-32475)
(NASA-CR-3396; SSD-80-0108-5) Avail: NTIS HC A10/MF A01 CSCL 10A

Guidelines and ground rules followed in the development of requirements for the SPS are presented. Development planning objectives are specified in each of these areas, and evolutionary SPS program scenarios are described for the various concepts studied during the past one year contract. Program descriptions are presented as planning packages of technical tasks, and schedule phasing. Each package identifies the ground based technology effort that will facilitate SPS definitions, designs, development, and operations. T.M.

N81-22537# Argonne National Lab., Ill.
DESIGN REQUIREMENTS FOR ORBIT MAINTENANCE OF SPS ELEMENTS
Nov. 1980 70 p refs
(Contract W-31-109-ENG-38)
(DOE/ER-0087) Avail: NTIS HC A04/MF A01

The LEO Staging Base, Electric Orbit Transfer Vehicle, the LEO Construction Base, and SPS Self-Power Module are the SPS elements selected for this analysis. The orbit decay rates and attitude control/orbit maintenance propellant requirements for nominal and worst case conditions are defined. The sequence of events that could cause unplanned reentry are defined. The design and operational requirements that will be used to prevent the various elements from deorbiting are defined. DOE

N81-23595*# Rockwell International Corp., Downey, Calif. Space Operations and Satellite Systems Div.
SATELLITE POWER SYSTEMS (SPS) CONCEPT DEFINITION STUDY (EXHIBIT D). VOLUME 7: SYSTEM/SUBSYSTEMS REQUIREMENTS DATABOOK Final Report
G. M. HANLEY Washington NASA Mar. 1981 267 p
(Contract NAS8-32475)
(NASA-CR-3399; M-340-VOL-7; SSD-80-0108-7-VOL-7) Avail: NTIS HC A12/MF A01 CSCL 10B

This volume summarizes the basic requirements used as a guide to systems analysis, and is a basis for the selection of candidate Satellite Power Systems (SPS) point designs. Initially, these collected data reflected the level of definition resulting from the evaluation of a broad spectrum of SPS concepts. As the various concepts matured, these requirements were updated to reflect the requirements identified for the projected satellite system/subsystem point designs. Included is an updated version of earlier Rockwell concepts using klystrons as the specific microwave power amplification approach, as well as a more in-depth definition, analysis and preliminary point design on two concepts based on the use of advanced solid state technology to accomplish the task of high power amplification of the 2.45 GHz transmitted power beam to the Earth receiver. Finally, a preliminary definition of a concept using magnetrons as the microwave power amplifiers is presented. S.F.

N81-23599*# Rockwell International Corp., Canoga Park, Calif.
SATELLITE POWER SYSTEMS (SPS) CONCEPT DEFINITION STUDY, EXHIBIT F Final Report
G. M. HANLEY 28 Apr. 1981 157 p
(Contract NAS8-32475)
(NASA-CR-161750; SSD-81-0059) Avail: NTIS HC A08/MF A01 CSCL 10B

Preliminary technical data were derived for three new system satellite concepts. The concepts are: a geo-solar array and antenna with free-flying geo-solar reflector; a geo-solar array and antenna with free-flying geo-radio-frequency reflector; and a sun-synchronous solar array and antenna with free-flying geo-radio-frequency reflector. Parametric data are provided on microwave sidelobe reduction as a function of design changes. T.M.

N81-24146*# Grumman Aerospace Corp., Bethpage, N.Y.
MANNED GEOSYNCHRONOUS MISSION REQUIREMENTS AND SYSTEMS ANALYSIS STUDY EXTENSION. VOLUME 1: EXECUTIVE SUMMARY Final Report
Feb. 1981 53 p
(Contract NAS9-15779)
(NASA-CR-160955) Avail: NTIS HC A04/MF A01 CSCL 22A

A study was performed to determine the types of manned missions that will likely be performed in the late 1980's or early 1990's timeframe, to define MOTV configurations which satisfy these missions requirements, and to develop a program plan for its development. Twenty generic missions were originally defined for MOTV but, to simplify the selection process, five of these missions were selected as typical and used as Design Reference Missions. Systems and subsystems requirements were re-examined and sensitivity analyses performed to determine optimum point designs. Turnaround modes were considered to determine the most effective combination of ground based and spaced based activities. A preferred concept for the crew capsule and for the mission mode was developed. T.M.

N81-25137*# Astro Research Corp., Carpinteria, Calif.
CONCEPTUAL DESIGN STUDIES FOR LARGE FREE-FLYING SOLAR-REFLECTOR SPACECRAFT
J. M. HEDGEPETH, R. K. MILLER, and K. P. W. KNAPP NASA Jun. 1981 125 p refs
(Contract NAS1-15347)
(NASA-CR-3438; ARC-R-1015) Avail: NTIS HC A06/MF A01 CSCL 22B

The 1 km diameter reflecting film surface is supported by a lightweight structure which may be automatically deployed after launch in the Space Shuttle. A twin rotor, control moment gyroscope, with deployable rotors, is included as a primary control actuator. The vehicle has a total specific mass of less than 12 g/sq m including allowances for all required subsystems. The structural elements were sized to accommodate the loads of a typical SOLARES type mission where a swam of these free flying satellites is employed to concentrate sunlight on a number of energy conversion stations on the ground. T.M.

N81-25561*# Argonne National Lab., Ill.
SURVEY AND DOCUMENTATION OF EMERGING TECHNOLOGIES FOR THE SATELLITE POWER SYSTEM (SPS)
P. GLASER and P. CHAPMAN (Little (Arthur D.), Inc.) Apr. 1981 133 p refs Sponsored in part by NASA
(Contract W-31-109-ENG-38)
(NASA-CR-164418; DOE/ER-0097) Avail: NTIS HC A07/MF A01 CSCL 01A

The genesis of the solar power satellite (SPS) concept is reviewed historically and the original assumptions and guidelines which led to development of the SPS reference system design concept are discussed. Some guidelines are applicable to almost any SPS design, but others can be changed, leading to new and perhaps preferable systems. In order to stimulate new SPS concepts and to facilitate comparative assessment of emerging SPS technologies, one useful approach is to break the overall system into functional parts. The system functions which must be performed by any SPS concept and the interrelations between them are discussed and a systematic framework is presented for assessing the wide variety of system concepts and subsystem technologies which have been proposed. About 80 alternative SPS technologies are reviewed. DOE

N81-26164*# Communications Satellite Corp., Clarksburg, Md.
GEOSTATIONARY PLATFORMS MISSION AND PAYLOAD REQUIREMENTS STUDY. VOLUME 1: EXECUTIVE SUMMARY Final Report, 12 Oct. 1978 - 18 Oct. 1979
30 Oct. 1979 93 p refs 2 Vol.
(Contract NAS8-33226)
(NASA-CR-161807) Avail: NTIS HC A05/MF A01 CSCL 22B

Time-phased missions and payloads for potential accommodation on geostationary platforms and the engineering requirements placed upon the platform housekeeping elements by selected payloads are identified. Optimum locations for geostationary platforms, potential missions and their characteristics, and potential user requirements were determined as well as the interface requirements between the missions and h the geostationary platform. A payload data book was prepared and antenna tradeoff studies were conducted. Payload missions are defined in terms of frequencies, power, beam patterns, interconnections, support requirements, and other characteristics. J.M.S.

N81-26165*# Communications Satellite Corp., Clarksburg, Md.
GEOSTATIONARY PLATFORMS MISSION AND PAYLOAD REQUIREMENTS STUDY. VOLUME 2: TECHNICAL Final Report, 12 Oct. 1978 - 18 Oct. 1979
30 Oct. 1979 151 p refs 2 Vol.
(Contract NAS8-33226)
(NASA-CR-161808) Avail: NTIS HC A08/MF A01 CSCL 22B

The possibility of using geostationary platforms to provide communications and other services was examined. Detailed data on the payload and housekeeping requirements of selected communications missions and one typical noncommunications mission are presented. J.M.S.

N81-27622*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.
SATELLITE POWER SYSTEM: CONCEPT DEVELOPMENT AND EVALUATION PROGRAM. VOLUME 3: POWER TRANSMISSION AND RECEPTION. TECHNICAL SUMMARY AND ASSESSMENT
R. H. DIETZ, G. D. ARNDT, J. W. SEYL, L. LEOPOLD, and J. S. KELLEY Jul. 1981 280 p refs
(NASA-RP-1076; S-507) Avail: NTIS HC A13/MF A01 CSCL 10A

Efforts in the DOE/NASA concept development and evaluation program are discussed for the solar power satellite power transmission and reception system. A technical summary is provided together with a summary of system assessment activities. System options and system definition drivers are described. Major system assessment activities were in support of the reference system definition, solid state system studies, critical technology supporting investigations, and various system and subsystem tradeoffs. These activities are described together with reference system updates and alternative concepts for each of the subsystem areas. Conclusions reached as a result of the numerous analytical and experimental evaluations are presented. Remaining issues for a possible follow-on program are identified. A.R.H.

N81-29491*# Harvard-Smithsonian Center for Astrophysics, Cambridge, Mass.
INTERACTIONS OF A TETHERED SATELLITE SYSTEM WITH THE IONOSPHERE Summary Report
M. D. GROSSI and G. COLOMBO *In* Alabama Univ. UAH/NASA Workshop on the Use of a Tethered Satellite System p 177-181 May 1978 refs
Avail: NTIS HC A11/MF A01 CSCL 04A

The Tethered Satellite System will be the first large structure deployed in space. It will react strongly with the magneto-ionic medium of the Earth's ionosphere and will thus be valuable experimental tool. Experiments planned for the structure are discussed. Emphasis is placed on the structures ability to excite a large variety of wave phenomena in the ionosphere using its electromotive force. T.M.

N81-29493*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
SHUTTLE/TETHERED SATELLITE SYSTEM
C. C. RUPP and J. H. LAUE *In* Alabama Univ. UAH/NASA Workshop on the Use of a Tethered Satellite System p A9-A30 May 1978 refs Presented at the Goddard Memorial Symp., Washington, D.C., 8-10 Mar. 1978
Avail: NTIS HC A11/MF A01 CSCL 22B

A tethered satellite system was conceived as a device to extend the capability of the Space Shuttle to perform scientific/applications investigations and operational activities. The concept envisions a multiple-use tethered system with closed-loop control, capable of supporting a payload or satellite suspended from the Shuttle cargo bay, toward or away from the Earth, at distances up to 100 kilometers from the Shuttle. The background and results of early analyses and feasibility studies are discussed and a design and operational description of the system are presented. Also presented are a discussion of potential applications of the Tethered Satellite System, and plans for an operational verification flight in 1982. T.M.

N81-29546*# Argonne National Lab., Ill.
ASSESSMENT OF A SATELLITE POWER SYSTEM AND SIX ALTERNATIVE TECHNOLOGIES
T. WOLSKO, R. WHITFIELD, M. SAMSA, L. S. HABEGGER, E. LEVINE, and E. TANZMAN Apr. 1981 230 p refs
(Contract W-31-109-ENG-38)
(NASA-CR-164598; DOE/ER-0099) Avail: NTIS HC A11/MF A01 CSCL 10A

The satellite power system is assessed in comparison to six alternative technologies. The alternatives are: central-station terrestrial photovoltaic systems, conventional coal-fired power plants, coal-gasification/combined-cycle power plants, light water reactor power plants, liquid-metal fast-breeder reactors, and fusion. The comparison is made regarding issues of cost and performance, health and safety, environmental effects, resources, socio-economic factors, and institutional issues. The criteria for selecting the issues and the alternative technologies are given, and the methodology of the comparison is discussed. Brief descriptions of each of the technologies considered are included. DOE

N81-29593# Argonne National Lab., Ill. Energy and Environmental Systems Div.
COST COMPARISON OF THE SATELLITE POWER SYSTEM (SPS) AND SIX ALTERNATIVE TECHNOLOGIES
T. WOLSKO and M. SAMSA Apr. 1981 119 p refs
(Contract W-31-109-ENG-38)
(ANL/EES/TM-133) Avail: NTIS HC A06/MF A01

A method to compare the Satellite Power System (SPS) with various projected alternative energy sources on the basis of technical possibility, economic viability, and social and environmental acceptability is described. The following energy sources are briefly described: conventional coal, light water reactor, coal gasification/combined cycle, liquid metal fast breeder reactor, central station terrestrial photovoltaic, fusion, and the SPS. DOE

N81-32170*# Lockheed Missiles and Space Co., Sunnyvale, Calif.
SATELLITE SERVICES SYSTEM ANALYSIS STUDY. VOLUME 2, PART 2: STUDY RESULTS Final Report
22 Jul. 1981 49 p refs 2 Vol.
(Contract NAS9-16121)
(NASA-CR-161050-VOL-2-PT-2; LMSC-D764514-VOL-2-PT-2)
Avail: NTIS HC A03/MF A01 CSCL 22A

The development of an effective satellite services system was investigated. Satek Satellite user market, design reference missions, satellite service functions, service equipment, and cost estimates are discussed. Extensive program plans for a satellite service system implementation are included. J.M.S.

N81-32604*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.
SATELLITE POWER SYSTEM CONCEPT DEVELOPMENT AND EVALUATION PROGRAM. VOLUME 2: SYSTEM DEFINITION
Jul. 1981 116 p refs
(NASA-TM-58236; JSC-17300) Avail: NTIS HC A06/MF A01 CSCL 10A

The system level results of the system definition studies performed by NASA as a part of the Department of Energy/NASA satellite power system concept development and evaluation program are summarized. System requirements and guidelines are discussed as well as the major elements that comprise the reference system and its design options. Alternative system approaches including different system sizes, solid state amplifier (microwave) concepts, and laser power transmission system cost summaries are reviewed. An overview of the system analysis and planning efforts is included. The overall study led to the conclusion that the reference satellite power system concept is a feasible baseload source of electrical power and, within the assumed guidelines, the minimum cost per kilowatt is achieved at the maximum output of 5 gigawatts to the utility grid. Major unresolved technical issues include maximum allowable microwave power density in the ionosphere and performance/mass characteristics of laser power transmission systems. A.R.H.

02

ANALYSIS AND DESIGN

Includes interactive techniques, computerized technology design and development programs, dynamic analysis techniques, environmental modeling, thermal modeling, and math modeling.

A81-32434
REVIEW OF THE NEAR-EARTH SPACECRAFT ENVIRONMENT
H. B. GARRETT (USAF, Geophysics Laboratory, Bedford, Mass.) In: Optics in adverse environments; Proceedings of the Seminar, Los Angeles, Calif., February 4, 5, 1980. Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1980, p. 109-115. refs

This paper reviews those aspects of the near-earth space environment that could have potentially adverse effects on electro-optical systems and their operations in space. As such systems have grown in complexity, their susceptibility to damage by the space environment has grown comparably. As the mission lifetimes have increased, the long term effects of radiation damage, spacecraft charging, and surface contamination have become significant concerns. Current models of the charged particle environment responsible for these effects are presented from the standpoint of their applicability to design needs. Although much still needs to be done, these models are sufficiently accurate that significant improvements can be made in system survivability if the models are employed early in the design phase. (Author)

A81-33607* Smithsonian Astrophysical Observatory, Cambridge, Mass.
OPTIMUM SHAPE OF A KIRKPATRICK-BAEZ X-RAY REFLECTOR SUPPORTED AT DISCRETE POINTS FOR ON-AXIS PERFORMANCE
L. M. COHEN (Smithsonian Astrophysical Observatory, Cambridge, Mass.) Applied Optics, vol. 20, May 1, 1981, p. 1545-1549. refs
(Contract NAS5-26024)

A method is proposed for optimizing the on-axis resolution of a Kirkpatrick-Baez reflecting element. The proposed procedure provides a way to determine the location of each of the 11,200 support points (175 different points plus repeats) by using a computer-assisted structural-optical software package. This automated procedure will make it possible to determine the optical characteristics of an entire telescope module consisting of seventy mirrors. V.L.

A81-36618* Duke Univ., Durham, N. C.
ON NUMERICAL NONLINEAR ANALYSIS OF HIGHLY FLEXIBLE SPINNING CANTILEVERS
S. UTKU, M. EL-ESSAWI (Duke University, Durham, N.C.), and M. SALAMA (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.) (George Washington University and NASA, Symposium on Computational Methods in Nonlinear Structural and Solid Mechanics, Washington, D.C., Oct. 6-8, 1980.) Computers and Structures, vol. 13, June 1981, p. 349-355. refs
(Contract NAS7-100)

The general nonlinear discretized equations of motion of spinning elastic solids and structures are derived as a set of nonlinear ordinary differential equations for the case when the strain-displacement and velocity-displacement relations are nonlinear up to the second order. It is shown that the cost of generation of such equations is proportional to the fourth power of the number of degrees of freedom. A computer program is written to automatically generate the equations for the case of spinning cantilevers with initial imperfections. The types and the number of the coordinate functions used in the trial solution are parameters of the program. (Author)

A81-37326#

A HOMOLOGOUS OPTIMIZATION DESIGN OF LARGE ANTENNA STRUCTURE

S.-H. WANG, Z.-L. LI, Q.-Q. WANG, K.-Y. LI, and Z.-H. CHEN (Shanghai Science and Technology University, Shanghai, Communist China) Acta Mechanica Solida Sinica, no. 1, 1981, p. 12-26. In Chinese, with abstract in English.

This paper presents an optimization method for the antenna structure design problem in which the target function is the weighted rms of the deviation of the deflected surface from the best-fit paraboloid. The complicated target function is partially linearized by using the derivative matrix, and reduced to a quadratic convex function. Then, this quadratic convex programming problem is changed to a linear programming one with an additional condition which can be solved with a modified simplex method. The optimization parameters include member sections, plate thicknesses, joint coordinates and ratio coefficients between member sections. Several numerical examples show that this approach gives satisfactory results. (Author)

A81-39096#

CONSIDERATION OF THE EFFECT OF RETICULATE SHADING UPON RADIATION HEAT TRANSFER BY MEANS OF EMISSIVITY REDUCTION

R. BEST and F. ZILLY (Dornier System GmbH, Friedrichshafen, West Germany) American Institute of Aeronautics and Astronautics, Thermophysics Conference, 16th, Palo Alto, CA, June 23-25, 1981, 9 p.
(AIAA PAPER 81-1093)

A technique is presented which simplifies consideration of the effect on the radiation heat transfer from areas which are shaded by reticulate surfaces, and which can be applied to thermal control considerations in the design of space structures. The technique was developed during the thermal design phase of the Space Telescope Faint Object Camera program. The technique is a useful instrument for simulating shading effects caused by net-like structures, such as electronic harnesses and grid covers, by reducing the emissivity values of the shaded surfaces. The analytically derived equation for the emissivity reduction, as a function of the shading factor and the emissivities of shading and shaded surfaces, is adequate for spacecraft applications. Small inaccuracies in determining the temperature must be taken into account when emissivity reduction is applied, as in the case of the example which resulted in a temperature uncertainty of + or - 1 K. However, the advantage of the method, i.e., a reduction in analysis effort, as well as a significant decrease in computer time and costs, compensate for the disadvantage. K.S.

A81-39156*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

INTERACTIVE DESIGN AND ANALYSIS OF FUTURE LARGE SPACECRAFT CONCEPTS

L. B. GARRETT (NASA, Langley Research Center, Space Systems Div., Hampton, VA) American Institute of Aeronautics and Astronautics, Thermophysics Conference, 16th, Palo Alto, CA, June 23-25, 1981, 16 p. refs
(AIAA PAPER 81-1177)

Recent developments in interactive computer-aided design and analysis of future large spacecraft concepts are presented. The primary emphases are on automatic spacecraft modeling for lattice (truss-like) structures and simplified multidiscipline design and analysis modules. Capabilities and performance of the twenty some applications modules, the executive and data management software, and graphics display features are reviewed. Data generated for an earth-orbiting large diameter (750 meter) antenna satellite are used to illustrate current capabilities. A single user at an interactive terminal can create, design, analyze, and conduct parametric studies of earth-orbiting spacecraft with relative ease. The approach is particularly useful in the conceptual design phase of advanced space missions when a multiplicity of concepts must be evaluated in a cost-effective and timely manner (Author)

A81-39157#

AN ACCURATE AND EFFICIENT METHOD FOR THERMAL/THERMOELASTIC PERFORMANCE ANALYSIS OF LARGE SPACE STRUCTURES /LSS/

B. C. CHAMBERS, C. L. JENSEN, and J. V. COYNER (Martin Marietta Aerospace, Engineering Mechanics Dept., Denver, CO) American Institute of Aeronautics and Astronautics, Thermophysics Conference, 16th, Palo Alto, CA, June 23-25, 1981, 8 p.
(AIAA PAPER 81-1178)

Thermal analysis methods developed to accurately predict the temperature data needed to perform thermoelastic deformation analyses of large, truss-type space structures in a cost-effective manner are presented. Such large, open structures are subject to effects that cannot be neglected as they are in the case of conventionaly-sized spacecraft, such as umbra and penumbra shadowing. Among the features of the method are: (1) neglect of interelement radiation effects; (2) consideration of circumferential gradients in cylindrical elements; (3) inclusion of umbra-penumbra solar shadowing and local heat source effects; and (4) accommodation of variable-transmittance mesh surfaces. O.C.

A81-39158#

SPACE STRUCTURE HEATING /SSQ/ A NUMERICAL PROCEDURE FOR ANALYSIS OF SHADOWED SPACE HEATING OF SPARSE STRUCTURES

R. F. ONEILL and J. L. ZICH (General Dynamics Corp., Convair Div., San Diego, CA) American Institute of Aeronautics and Astronautics, Thermophysics Conference, 16th, Palo Alto, CA, June 23-25, 1981, 9 p.
(AIAA PAPER 81-1179)

The General Dynamics Convair Division Space Structure Heating (SSQ) computer program has been developed to address and quantify the complex solar shadowing conditions inherent in sparse, lattice-type space structures. The analysis procedure is one of assessing partial shadowing of structural elements by multiple, similar slender members. The program yields schedules of incident solar, earth thermal, and earth albedo radiation throughout a complete orbit, and with respect to elemental locations on selected structural members. Thermal response can be computed in an optional routine. Complete heat flux and temperature mapping can be obtained by repeated computations for selected elements of interest. The analysis method is detailed, and selected topics of the mathematical development are presented. Graphic display of typical output data is included. (Author)

A81-39200*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

INTEGRATED COMPUTER-AIDED DESIGN USING MINICOMPUTERS

O. O. STORAASLI (NASA, Langley Research Center, Integrated Programs for Aerospace-Vehicle Design Projects Office, Hampton, VA) American Society of Civil Engineers, Convention and Exposition, Hollywood, FL, Oct. 27-31, 1980, 17 p. refs
(ASCE PREPRINT 80-671)

Computer-Aided Design/Computer-Aided Manufacturing (CAD/CAM), a highly interactive software, has been implemented on minicomputers at the NASA Langley Research Center. CAD/CAM software integrates many formerly fragmented programs and procedures into one cohesive system; it also includes finite element modeling and analysis, and has been interfaced via a computer network to a relational data base management system and offline plotting devices on mainframe computers. The CAD/CAM software system requires interactive graphics terminals operating at a minimum of 4800 bits/sec transfer rate to a computer. The system is portable and introduces 'interactive graphics', which permits the creation and modification of models interactively. The CAD/CAM system has already produced designs for a large area space platform, a national transonic facility fan blade, and a laminar flow control wind tunnel model. Besides the design/drafting element analysis capability, CAD/CAM provides options to produce an automatic program tooling code to drive a numerically controlled (N/C) machine. Reductions in time for design, engineering, drawing, finite element modeling, and N/C machining will benefit productivity through reduced costs, fewer errors, and a wider range of configuration. J.F.

A81-47482
MODEL UNCERTAINTIES AND APPROXIMATIONS IN LARGE SPACE SYSTEM THERMAL ANALYSIS
C. ARDUINI (Roma, Universita, Rome, Italy) International Astronautical Federation, International Astronautical Congress, 32nd, Rome, Italy, Sept. 6-12, 1981, 17 p. refs
(IAF PAPER 81-376)

Thermal modeling concepts and techniques for large space systems are discussed with emphasis on computational problems and compatibility with the structure. Consideration is given to the sources of uncertainties in thermal modeling such as nongray, nondiffuse, and nonspecular effects, finite nonisothermal surfaces and volumes in radiation and conduction, uncertainties in conductivity, and limitations in numerical integration. Considerations are presented which may help identify the areas where the large space structure verification modeling may be simplified or refined. V.L.

A81-47483
SIMILARITY RULES AND POSSIBLE APPLICATIONS FOR GROUND HEAT BALANCE TESTS OF LARGE SPACE SYSTEMS
U. PONZI (Roma, Universita, Rome, Italy) International Astronautical Federation, International Astronautical Congress, 32nd, Rome, Italy, Sept. 6-12, 1981, 12 p. European Space Agency refs
(Contract ESA-4348/80-NL-AK)
(IAF PAPER 81-377)

Large space structures introduce serious problems for ground testing operations, particularly with respect to heat balance tests, which are subject to the static or dynamic coupling between radiation and deformation. A similarity analysis is carried out in order to determine the feasibility of ground tests using reduced-size models. The structural dynamics and thermal-mechanic processes, as well as the radiation and conduction processes are deduced from the equations of full geometric similarity. With respect to a combined structural dynamics-radiation-conduction-thermal distortion, no-length scaling is shown to be the most practical and is conditioned by a change in both the optical and internal properties of the material. A slight length scaling of coupled radiation conduction-thermal distortion is possible by modifying only the optical characteristics. Full-length scaling, keeping all the material properties constant, is suggested for uncoupled radiation distortion. J.F.

A81-47488
DYNAMIC RESPONSE OF LARGE SPACE STRUCTURES
P. SANTINI, C. BOTTIGLIERI, and M. MARCHETTI (Roma, Universita, Rome, Italy) International Astronautical Federation, International Astronautical Congress, 32nd, Rome, Italy, Sept. 6-12, 1981, 43 p. Research sponsored by the Universita di Roma.
(IAF PAPER 81-382)

It is shown that there are several procedures for the solution of the dynamic problems of large space structures which obviate the use of large, general purpose programs. After consideration of a one-dimensional string of bays for which the most general mass and stiffness equations are derived, a procedure similar to numerical integration is introduced and extended to the case of bi-periodic structures. Two-dimensional structures are then treated in terms of a method, very similar to those applicable to partial differential equations, which incorporates finite elements and the separation of variables. Included are detailed graphic representations of structural modes from a set of numerical examples. O.C.

A81-48377
A MODULAR APPROACH TO THE SIMULATION OF LARGE SPACE STRUCTURES
M. HASSUL and D. L. HEFFERNAN (Boeing Co., Seattle, WA) In: Summer Computer Simulation Conference, Seattle, WA, August 25-27, 1980, Proceedings. Arlington, VA, AFIPS Press, 1980, p. 590-592.

A simulation package has been developed which models a spacecraft configuration consisting of a main body and several appendages, each attached to the spacecraft body via two axis gimbals. A modular approach is taken for writing both the linear and nonlinear dynamic equations. The dynamic analysis of the structure is performed by using several computer modules. A structural analysis module (NASTRAN) is used to derive the mass, stiffness, and modal data for each of the substructures; another module (MODE SELECTOR) reduces the order of the flexible problem by allowing the designer to select a subset of critical modes for further study. Finally, the data is formatted so that it can be directly input to the final module, EASY5, where the vehicle dynamic equations (linear and nonlinear) are simulated. V.L.

N81-28136*# Systems Science and Software, La Jolla, Calif.
ADDITIONAL APPLICATION OF THE NASCAP CODE. VOLUME 1: NASCAP EXTENSION Final Report, Mar. 1979 - Oct. 1980
I. KATZ, J. J. CASSIDY, M. J. MANDELL, D. E. PARKS, G. W. SCHNUELLE, P. R. STANNARD, and P. G. STEEN Feb. 1981 126 p refs 2 Vol.
(Contract NAS3-21762)
(NASA-CR-165349; SSS-R-81-4847-VOL-1) Avail: NTIS HC A07/MF A01 CSCL 22B

The NASCAP computer program comprehensively analyzes problems of spacecraft charging. Using a fully three dimensional approach, it can accurately predict spacecraft potentials under a variety of conditions. Several changes were made to NASCAP, and a new code, NASCAP/LEO, was developed. In addition, detailed studies of several spacecraft-environmental interactions and of the SCATHA spacecraft were performed. The NASCAP/LEO program handles situations of relatively short Debye length encountered by large space structures or by any satellite in low earth orbit (LEO). T.M.

03

STRUCTURAL CONCEPTS AND ANALYSIS

Includes erectable structures (joints, struts, and columns), deployable platforms and booms, solar sail, deployable reflectors, space fabrication techniques, and protrusion processing.

A81-31391* General Dynamics/Convair, San Diego, Calif.
MODULAR SPACE STRUCTURES
D. H. VAUGHAN (General Dynamics Corp., Convair Div., San Diego, Calif.) Society of Allied Weight Engineers, Annual Conference, 39th, St. Louis, Mo., May 12-14, 1980, 24 p.
(SAWE PAPER 1371)

The Extendable Tetrahedral Truss orbiting antenna concept, comprising the use of prefabricated, automatically deployable lattice structures and their subsequent assembly into larger structures suitable for microwave antenna use, is described. It is assumed that the Space Shuttle Orbiter payload bay will be able to accommodate only modular portions of the structural system required, and that the Space Shuttle crew will furnish the manual labor entailed by orbital assembly. It is concluded that a deployable beam module system may be a more elegant design solution than the alternative triangular-module system. O.C.

03 STRUCTURAL CONCEPTS AND ANALYSIS

A81-31393

STRUCTURAL ANALYSIS OF LARGE HEXAGONAL COMPRESSION FRAME/TENSION CABLE ARRAY STRUCTURE FOR SPS MICROWAVE ANTENNA

H. S. GREENBERG (Rockwell International Corp., Space Operations and Satellite Systems Div., Seal Beach, Calif.) Society of Allied Weight Engineers, Annual Conference, 39th, St. Louis, Mo., May 12-14, 1980, 25 p.
(SAWE PAPER 1373)

A structural analysis is presented for the large aperture diameter Microwave Power Transmission System (MPTS) antenna required by prospective Satellite Power Systems. Requirements for this orbital structure are severe, with aperture diameters of between 1 and 2 km and the maintenance of array surface flatness from 1/8 to 1/2 m. The proposed structure is composed of an orthogonal array of cables, stabilized by a peripheral compression-carrying frame that provides the primary structural support system. The critical structural requirements, load stability criteria, and parametric load/deflection analysis methodology are described. O.C.

A81-31394* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

DEPLOYABLE AND ERECTABLE CONCEPTS FOR LARGE SPACECRAFT

H. G. BUSH, W. L. HEARD, JR., J. E. WALZ, and J. J. REHDER (NASA, Langley Research Center, Hampton, Va.) Society of Allied Weight Engineers, Annual Conference, 39th, St. Louis, Mo., May 12-14, 1980, 23 p. refs
(SAWE PAPER 1374)

The structural proportions of minimum-mass tetrahedral truss platforms designed for low earth and geosynchronous orbit are determined by means of computerized sizing techniques, taking into account multiple design requirements and constraints. Strut dimensions characterizing minimum mass designs are found to be significantly more slender than those used for conventional structural applications. It is also shown that the number of shuttle flights required by deployable trusses becomes excessive above certain critical stiffness values, and that an automated assembler can achieve rates of 1 min/strut, by comparison with 2-5 min/strut for two astronauts using manual labor. O.C.

A81-31395* Astro Research Corp., Carpinteria, Calif.

ACCURACY POTENTIALS FOR LARGE SPACE ANTENNA STRUCTURES

J. M. HEDGEPETH (Astro Research Corp., Carpinteria, Calif.) Society of Allied Weight Engineers, Annual Conference, 39th, St. Louis, Mo., May 12-14, 1980, 36 p.
(Contract NAS1-15347)
(SAWE PAPER 1375)

The relationships among materials selection, truss design, and manufacturing techniques in the interest of surface accuracies for large space antennas are discussed. Among the antenna configurations considered are: tetrahedral truss, pretensioned truss, and geodesic dome and radial rib structures. Comparisons are made of the accuracy achievable by truss and dome structure types for a wide variety of diameters, focal lengths, and wavelength of radiated signal, taking into account such deforming influences as solar heating-caused thermal transients and thermal gradients. O.C.

A81-40465#

SPACECRAFT STRUCTURAL ANALYSIS ACTIVITIES AT ESTEC

C. STAVRINIDIS (ESA, Technical Directorate, Noordwijk, Netherlands) ESA Bulletin, no. 26, May 1981, p. 41-47.

Structural analysis techniques used at ESTEC to assess the structural integrity of spacecraft subjected to time dependent loads, such as lift-off transients, are discussed. The mathematical basis of the finite-element displacement method is presented. Important features of the structural analysis software, including the libraries of structural engineering computational procedures, element types, material properties, load functions, and graphics packages, are described. Practical procedures used in the development and assessment of spacecraft structures are outlined. Test data for the Exosat mechanical model are compared with modes and frequencies obtained analytically. C.K.D.

A81-43372* RCA Government Systems Div., Moorestown, N. J.

PRELIMINARY DESIGN OF LARGE REFLECTORS WITH FLAT FACETS

P. K. AGRAWAL (RCA, Missile and Surface Radar Div., Moorestown, NJ), M. S. ANDERSON, and M. F. CARD (NASA, Langley Research Center, Hampton, VA) IEEE Transactions on Antennas and Propagation, vol. AP-29, July 1981, p. 688-694. refs

A concept for approximating curved antenna surfaces using flat facets is discussed. A preliminary design technique for determining the size of the reflector surface facets necessary to meet antenna surface accuracy requirements is presented. A proposed large microwave radiometer satellite (MRS) is selected as an application, and the far-field electromagnetic response of a faceted reflector surface is compared with that from a spherical reflector surface. (Author)

A81-43656

JOINING OF GRAPHITE FIBER REINFORCED THERMOPLASTICS FOR GEODETIC BEAMS

W. A. ROSENE and V. L. FREEMAN (McDonnell Douglas Astronautics Co., Huntington Beach, CA) In: Materials 1980; Proceedings of the Twelfth National Technical Conference, Seattle, WA, October 7-9, 1980. Azusa, CA, Society for the Advancement of Material and Process Engineering, 1980, p. 857-869.

A study is presented of graphite fiber reinforced thermoplastic geodetic beam nodal joining techniques, to be used for on-orbit construction of large truss-type space structures. The geodetic beam is a lightweight open-lattice structure composed of an equilateral gridwork of crisscrossing rods. The beam assembler joining subsystem is critical to the operation of the beam builder, because there are thousands of nodal points per mile of beams, and limited onboard power. Nine basic joining techniques are evaluated, and include: (1) ultrasonic welding, (2) adhesive bonding, (3) tying, (4) taping, (5) stapling, (6) solvent bonding, (7) joint encapsulation, (8) pinning, and (9) resistance welding. The approaches to joining and the rationale for each of them are presented. Testing of the cylinders includes buckling, torsion, shear, and compressive buckling. The failure mode of cylinders with encapsulated joints is local rib buckling, and that of the resistance-welded cylinder features failure to about 22% of the welded joints along with local rib buckling. The most striking result is the high buckling stability exhibited by cylinders with encapsulated joints. K.S.

A81-40632

STRUCTURES MATCHING THE SPACE ENVIRONMENT - BRIDGES OR SPIDER WEBS

H. L. MAYER (Aerospace Corp., Advanced Systems Technology Div., El Segundo, CA) In: Space - Enhancing technological leadership; Proceedings of the Twenty-seventh Annual Meeting, Boston, MA, October 20-23, 1980. San Diego, CA, American Astronautical Society; Univelt, Inc., 1981, p. 511-527.
(AAS 80-276)

In view of future exploitation of outer space, visionary consideration is given to the construction of large space structures, stressing the idea of avoiding biases based on being accustomed to ground structures. For a space race, isolation would be achieved by great geometrical separation, rather than by cave-like thick walls; units would be connected by very thin cables, gently controlled in the gravity gradient field, and enclosing surfaces would be made of gossamer thin films. A space personnel bubble is described, which would have walls made of a flexible multilayer plastic film, and it would be inflated to size with air at normal temperature and pressure. A complex configuration of a tethered swarm (which keeps space objects together in the same orbit, while keeping them isolated from each other) is presented, where 10 outlying 2,000 kg stations are connected by a variety of flexible tethers to a 20,000 kg central area. The dynamics of such structures will be dominated by orbital mechanics. Potential applications include isolated research stations, solar sail vehicles, and solar flux concentrators. K.S.

A81-47484
LARGE SPACE STRUCTURES CONCEPTS USING NEW SOLUTIONS TO THE VOLUME CONSTRAINT PROBLEM
T. C. TAYLOR (Taylor and Associates, Inc., Jackson, MS) International Astronautical Federation, International Astronautical Congress, 32nd, Rome, Italy, Sept. 6-12, 1981, 14 p. refs
(IAF PAPER 81-378)

The Space Shuttle volume constraints on the ferrying of large space structures are addressed by the Aft Cargo Compartment (ACC) concept, in which storage volume is added to the Space Shuttle External Tank (ET) with the minimum disruption of current fabrication procedures and minimum additional cost. It is required only that the ET be taken to orbit with the addition of a small rocket motor using the boost phase's residual propellant. The implications of the addition of 13,000 cu ft in terms of a deployable large space structure truss beam are discussed. Attention is also given to the possible orbital uses of spent ETs, including: (1) a hangar for satellite repair and protection, (2) an orbital source of recoverable aluminum, (3) a large orbit transfer vehicle component, and (4) a nuclear waste disposal container. O.C.

A81-47486
JOINT TECHNOLOGIES AND JUNCTION CONCEPTS FOR LARGE SPACE SYSTEMS
E. TURCI and C. PORTELLI (Aeritalia S.p.A., Turin, Italy) International Astronautical Federation, International Astronautical Congress, 32nd, Rome, Italy, Sept. 6-12, 1981, 13 p.
(IAF PAPER 81-380)

Tentative design solutions for large space structure junctions and joints are studied, with attention given to a docking device that will provide both structural rigidity and alignment precision at the coupled surfaces under all conditions. The device is intended for use in the low earth orbit assembly of modular structures to form large platforms, and the availability of both the Space Shuttle remote manipulator system and IR docking sensors is assumed. IR docking configuration and operation, misalignment, tilt angle and distance measurements, retractable joint mechanisms with expansion petals, joint configuration and operation, and projected axial, tension and shear loads and motor torque experienced by the device are some of the points discussed. O.C.

A81-47487
DEVELOPMENT AND APPLICATION OF SPACE-DEPLOYABLE BOX TRUSS STRUCTURES
F. R. SCHWARTZBERG, J. V. COYNER, JR., and W. H. TOBEY (Martin Marietta Aerospace, Denver, CO) International Astronautical Federation, International Astronautical Congress, 32nd, Rome, Italy, Sept. 6-12, 1981, 13 p.
(IAF PAPER 81-381)

A development status report is given for the deployable box truss structural system, which is intended for use in such large space platforms as parabolic dish radio astronomy antennas. Attention is given the graphite-epoxy composite structural members and the mechanical design of their midlink latching hinges, integral end fitting, molded corner fitting, and telescoping tension members. It is argued that the design described offers: (1) compact stowage; (2) sequential deployment; (3) high dimensional precision; (4) high stiffness; (5) rigid attachment points for payloads and spacecraft; and (6) the possibility of application to a wide variety of spacecraft configurations. Stress is put on the compatibility of this structural concept with the payload capabilities of the Space Shuttle Orbiter, and a novel, 170 m-diameter radiometer with electrostatically shaped membrane surface is described. O.C.

A81-47489
COLLAPSIBLE ANTENNAE DEPLOYED BY ELECTROSTATIC FORCES
A. S. GVAMICHAVA, A. N. KOTIK, V. A. KOSHELEV, S. S. NEFEDOV, V. A. PATSAEVA, A. S. ROGACHEV, and A. G. SOKOLOV (Academy of Sciences, Intercosmos Council, Moscow, USSR) International Astronautical Federation, International Astronautical Congress, 32nd, Rome, Italy, Sept. 6-12, 1981, 15 p. refs
(IAF PAPER 81-383)

Conventional space mirror antennas occupy a substantial volume when folded; the dimensions of antennas, automatically extendable at orbit, may be reduced to magnitudes of about 100-200 m. These large mirror antennas are designed by means of thin films or mesh structures forming a reflecting surface, which are deployed by electrostatic forces. The interaction of charges applied to reflecting and subsidiary surfaces creates the electrostatic forces sustaining the structural form of the antenna. By varying the distribution of charges at the subsidiary shell, it is possible to change the structural form. Electrostatic forces in the shell must exceed outer influences, and the antenna should have a paraboloidal or spherical form and be made of soft materials, which can be extended by the forces of electrostatic charge interaction. Mirrors of considerable dimensions may be formed by combining a shell with stiffness rings; these rings are important factors defining the efficiency of the antenna, since they contribute to both the mass and the dimension of the antenna when packed. J.F.

N81-22397*# Martin Marietta Aerospace, Denver, Colo.
SPACE DEPLOYABLE TRUSS STRUCTURE DESIGN
J. V. COYNER, JR. and W. H. TOBEY *In* NASA. Marshall Space Flight Center The 15th Aerospace Mech. Symp. p 137-146 May 1981
Avail: NTIS HC A19/MF A01 CSCL 22B

The development status of the deployable box truss structure is summarized. Potential applications for this structural system are described. Structural and component design requirements derived from these applications are discussed. Components of prototype 4.6 m cubes which incorporate graphite/epoxy structural members, fittings, and mechanisms are described. The benefits of the component designs and their respective manufacturing processes are presented. E.D.K.

N81-22398*# Lockheed Missiles and Space Co., Sunnyvale, Calif.
ON THE DESIGN OF LARGE SPACE DEPLOYABLE MODULAR ANTENNA REFLECTORS
J. W. RIBBLE and A. A. WOODS, JR. *In* NASA. Marshall Space Flight Center The 15th Aerospace Mech. Symp. p 147-157 May 1981 refs
(Contract NAS1-14887)
Avail: NTIS HC A19/MF A01 CSCL 22B

The deployment kinematics, stowing philosophy, and deployment sequencing for large deployable antenna modules were verified. Mesh attachment methods compatible with full scale modules were devised. Parametric studies of large modular reflectors established size, mass, and aperture frequency capabilities for these assemblies. Preliminary studies were made devising means of delivering modules to orbit, and once there, of assembling the modules into complete modular antenna reflectors. The basic feasibility of creating mass efficient modules erectable into large structures in space was established. E.D.K.

N81-22399*# Lockheed Missiles and Space Co., Sunnyvale, Calif.

THE TECHNOLOGY DEVELOPMENT METHODOLOGY FOR A CLASS OF LARGE DIAMETER SPACEBORNE DEPLOYABLE ANTENNAS

W. D. WADE and V. C. MCKEAN *In* NASA. Marshall Space Flight Center The 15th Aerospace Mech. Symp. p 159-172 May 1981 refs

Avail: NTIS HC A19/MF A01 CSCL 22B

The application of thermally stable graphite epoxy materials in flexure is discussed and deployment mechanism designs that are adaptable to both the proof of concept and the full scale 100 meter system with no modification to the basic concept are presented. The ground deployment test techniques and mechanisms developed for ground demonstration and evaluation of large size antenna structures are presented to illustrate the complexities involved in supporting antenna structural elements in excess of 25 meters in length. Author

N81-22402*# British Aerospace Dynamics Group, Bristol (England).

A MECHANICAL DRIVE FOR RETRACTABLE TELESCOPIC MASTS

M. E. HUMPHRIES *In* NASA. Marshall Space Flight Center The 15th Aerospace Mech. Symp. p 205-217 May 1981

Avail: NTIS HC A19/MF A01 CSCL 13I

Test results on the mechanical drive have indicated that the system is capable of deploying a typical telescopic mast under ambient conditions. The design can be considered for a wide range of space applications since, in theory, there is no limit to the number of tubes that can be deployed. The mechanical system offers a number of advantages over a gas driven system, such as the ability to retract and also provide a significant mass saving. E.D.K.

N81-22405*# Dornier-Werke G.m.b.H., Friedrichshafen (West Germany).

AN ANTENNA POINTING MECHANISM FOR LARGE REFLECTOR ANTENNAS

H. HEIMERDINGER *In* NASA. Marshall Space Flight Center The 15th Aerospace Mech. Symp. p 253-261 May 1981 Sponsored in part by DFVLR

Avail: NTIS HC A19/MF A01 CSCL 13I

An antenna pointing mechanism for large reflector antennas on direct broadcasting communication satellites was built and tested. After listing the requirements and constraints for this equipment the model is described, and performance figures are given. Futhermore, results of the qualification level tests, including functional, vibrational, thermovacuum, and accelerated life tests are reported. These tests were completed successfully. Author

N81-22412*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

COMPARATIVE EVALUATION OPERABILITY OF LARGE SPACE STRUCTURE CONNECTORS

J. W. STOKES *In its* The 15th Aerospace Mech. Symp. p 357-374 May 1981

Avail: NTIS HC A19/MF A01 CSCL 22B

The evaluation of several connector concepts in the neutral buoyancy simulator is discussed. Parameters for evaluating the fasteners included subject comments and hardware damage. Evaluation results include a rank ordering of the candidates with descriptions of the acceptable and unacceptable points of each. General design recommendations established as a result of neutral buoyancy testing are defined. Recommendations include detailed hardware and operational design requirements. M.G.

N81-25258* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

LIGHTWEIGHT STRUCTURAL COLUMNS Patent

H. G. BUSH, inventor (to NASA) 7 Apr. 1981 9 p Filed 29 Jun. 1977 Supersedes N77-27432 (15 p2393)
(NASA-CASE-LAR-12095-1; US-PATENT-4,259,821;
US-PATENT-APPL-SN-811401; US-PATENT-CLASS-52-309.1;
US-PATENT-CLASS-52-648; US-PATENT-CLASS-52-726;
US-PATENT-CLASS-244-158R; US-PATENT-CLASS-403-171;
US-PATENT-CLASS-428-902) Avail: US Patent and Trademark Office CSCL 13B

Lightweight half-lengths of columns for truss structures are described. The columns are adapted for nestable storage and transport to facilitate fabrication of large area truss structures at a remote site and particularly adaptable for space applications.

Official Gazette of the U.S. Patent and Trademark Office

N81-25259* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

FOLDABLE BEAM Patent

J. M. HEDGEPETH (Astro Research Corp., Carpinteria, Calif.), J. V. COYNER (Astro Research Corp., Carpinteria, Calif.), and R. F. CRAWFORD (Astro Research Corp., Carpinteria, Calif.) 7 Apr. 1981 8 p Filed 23 Feb. 1979 Supersedes N79-25425 (17 - 16, p 2136) Sponsored by NASA
(NASA-CASE-LAR-12077-1; US-PATENT-4,259,825;
US-PATENT-APPL-SN-014663; US-PATENT-CLASS-52-645)
Avail: US Patent and Trademark Office CSCL 13I

A foldable beam possessing superior qualities of light weight, compactness for transportation, quick deployment with minimum use of force, and high strength is described. These qualities are achieved through the use of a series of longitudinally rigid segments, hinged along one side and threaded by one or two cables along the opposite side. Tightening the cables holds the beam extended. Loosening the cables permits the segments to fold away from the threaded side. In one embodiment the segments are connected by canted hinges with the result that the beam may be folded in a helix-like configuration around a cylinder. In another embodiment the segments themselves may be hinged to fold flat laterally as the beam is folded, resulting in a configuration that may be helixed around a shorter cylinder.

Official Gazette of the U.S. Patent and Trademark Office

N81-26493*# Cincinnati Univ., Ohio. Dept. of Aerospace Engineering and Applied Mechanics.

EFFECTIVE CONSTITUTIVE RELATIONS FOR LARGE REPETITIVE FRAME-LIKE STRUCTURES Semiannual Progress Report, period ending 30 Apr. 1981

A. H. NAYFEH and M. S. HEFZY 1981 33 p refs
(Contract NSG-1185)
(NASA-CR-164521) Avail: NTIS HC A03/MF A01 CSCL 20K

Effective mechanical properties for large repetitive framelike structures are derived using combinations of strength of material and orthogonal transformation techniques. Symmetry considerations are used in order to identify independent property constants. The actual values of these constants are constructed according to a building block format which is carried out in the three consecutive steps: (1) all basic planar lattices are identified; (2) effective continuum properties are derived for each of these planar basic grids using matrix structural analysis methods; and (3) orthogonal transformations are used to determine the contribution of each basic set to the overall effective continuum properties of the structure. S.F.

N81-27165*# McDonnell-Douglas Astronautics Co., Huntington Beach, Calif.
DEVELOPMENT OF A COMPOSITE GEODETIC STRUCTURE FOR SPACE CONSTRUCTION, PHASE 2 Final Report
30 Jul. 1981 104 p refs
(Contract NAS9-15678)
(NASA-CR-161017; MDC-G9390) Avail: NTIS HC A06/MF A01
CSCL 22B

Primary physical and mechanical properties were defined for pultruded hybrid HMS/E-glass P1700 rod material used for the fabrication of geodetic beams. Key properties established were used in the analysis, design, fabrication, instrumentation, and testing of a geodetic parameter cylinder and a lattice cone closeout joined to a short cylindrical geodetic beam segment. Requirements of structural techniques were accomplished. Analytical procedures were refined and extended to include the effect of rod dimensions for the helical and longitudinal members on local buckling, and the effect of different flexural and extensional moduli on general instability buckling. A.R.H.

N81-27323* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.
STRUCTURAL MEMBERS, METHOD AND APPARATUS Patent
J. A. KINZLER, inventor (to NASA) 9 Dec. 1980 21 p Filed 4 Apr. 1978 Supersedes N78-22146 (16 - 13, p 1672)
(NASA-CASE-MSC-16217-1; US-PATENT-4,237,662;
US-PATENT-APPL-SN-893383; US-PATENT-CLASS-52-108;
US-PATENT-CLASS-52-745) Avail: US Patent and Trademark Office CSCL 13B

A method and apparatus for fabricating a structural member such as truss from flexible sheet material in compacted form are disclosed. A number of generally tubular columns are progressively formed from the sheet material and deployed generally parallel to one another. Adjacent pairs of the columns are interconnected by respective side members, each of which is comprised of a strip of the sheet material. The sheet material is fastened together by self-attaching fasteners integrally formed from the sheet material of the columns and side members themselves.

Official Gazette of the U.S. Patent and Trademark Office

N81-27324* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
TELESCOPING COLUMNS Patent
J. T. MAZUR, inventor (to NASA) (Harris Corp., Melbourne, Fla.) 16 Dec. 1980 8 p Filed 29 Sep. 1978 Supersedes N78-33446 (16 - 24, p 3222) Sponsored by NASA
(NASA-CASE-LAR-12195-1; US-PATENT-4,238,911;
US-PATENT-APPL-SN-946991; US-PATENT-CLASS-52-111;
US-PATENT-CLASS-52-632; US-PATENT-CLASS-182-62.5;
US-PATENT-CLASS-212-267) Avail: US Patent and Trademark Office CSCL 13B

An extendable column is described which consists of several axially elongated rigid structural sections nested within one another. Each section includes a number of rotatably attached screws running along its length. The next inner section includes threaded lugs oriented to threadingly engage the screws. The column is extended or retracted upon rotation of the screws. The screws of each section are selectively rotated by a motor and an engagement mechanism.

Official Gazette of the U.S. Patent and Trademark Office

N81-31271*# Astro Research Corp., Carpinteria, Calif.
CONSIDERATIONS IN THE DESIGN OF LARGE SPACE STRUCTURES
J. M. HEDGEPETH, R. H. MACNEAL (MacNeal-Schwendler Corp., Los Angeles), K. KNAPP, and C. S. MACGILLIVRAY Aug. 1981 230 p refs
(Contract NAS1-15347)
(NASA-CR-165744; ARC-TN-1101) Avail: NTIS HC A11/MF A01 CSCL 22B

Several analytical studies of topics relevant to the design of large space structures are presented. Topics covered are: the types and quantitative evaluation of the disturbances to which large Earth-oriented microwave reflectors would be subjected and the resulting attitude errors of such spacecraft; the influence of errors in the structural geometry of the performance of radiofrequency antennas; the effect of creasing on the flatness of tensioned reflector membrane surface; and an analysis of the statistics of damage to truss-type structures due to meteoroids. T.M.

N81-31984 Arizona Univ., Tucson.
STRUCTURAL DESIGN OF A LARGE DEFORMABLE PRIMARY MIRROR FOR A SPACE TELESCOPE Ph.D. Thesis
J. G. R. HANSEN 1981 183 p
Avail: Univ. Microfilms Order No. 8116704

A 4-meter aperture deformable primary mirror is designed with the mirror and its supports integrated into a single structure. The 2 cm thick, solid ULE mirror is supported by a high modulus graphite epoxy truss structure. The integrated active mirror system is extremely light-weight, making it desirable for a space telescope, as well as for terrestrial applications. Utilizing displacement actuators, the active controls at the mirror's surface include position control and slope control in both the radial and tangential directions at each of the 40 actuator points. Influence functions for each of the controls are nearly independent, reducing the complexity of the control system. Experiments with breadboard models verify the structural concept and the techniques used in the finite element method of computer structural analysis for a system incorporating a solid mirror. The mechanical design of the servo-mechanisms and the flexures to connect the structural members is provided. Dissert. Abstr.

04

STRUCTURAL DYNAMICS AND CONTROL

Includes modeling, systems identification, attitude and control techniques, surface accuracy measurement and control techniques and systems, sensors and actuators.

A81-31294#
SIMULTANEOUS ECCENTRICITY AND DRIFT RATE CONTROL
C. F. GARTRELL (General Research Corp., McLean, Va.) Journal of Guidance and Control, vol. 4, May-June 1981, p. 310-315. refs

Comparatively large variations in orbital eccentricity are shown to be due to the disturbing force exerted by solar radiation pressure, so that the common approach to satellite stationkeeping for nearly circular orbits is inadequate. A control theory is presented which accounts for such annual satellite variations, simultaneously controlling both eccentricity and drift rate. It is concluded that future, large geosynchronous platform stationkeeping may be better addressed by a continuous thrusting scheme than the conventional control of eccentricity. O.C.

A81-32861*# Lockheed Missiles and Space Co., Sunnyvale, Calif.
MAGNETIC CONTROL SYSTEMS FOR LARGE SPACECRAFT WITH APPLICATIONS TO SPACE TELESCOPE
H. DOUGHERTY, J. MAUHNICK (Lockheed Missiles and Space Co., Inc., Sunnyvale, Calif.), A. NAKASHIMA, J. HENRY, and K. TOMPETRINI (Bendix Corp., Guidance Systems Div., Teterboro, N.J.) American Astronautical Society, Annual Rocky Mountain Guidance and Control Conference, Keystone, Colo., Jan. 31-Feb. 4, 1981, 23 p.
(Contract NAS8-32697)
(AAS PAPER 81-005)

Magnetic control systems for large space vehicles offer the advantage of a simple, reliable, low cost augmentation to the primary control system. When used for momentum management, a magnetic torque source offers a long life and noncontaminant environment when compared to a mass expulsion torque source.

These qualities make such systems suitable for employment with the Space Telescope, which is a long life, high performance vehicle with optics and scientific instruments which would be degraded by contamination due to mass expulsion products. The various applications of magnetic systems on the Space Telescope are considered. The future trend in magnetic control of large space vehicles lies in providing a known three axis reference for backup operations, such as recovery of the primary control mode. G.R.

A81-32884#
SENSING THE POSITION AND VIBRATION OF SPACECRAFT STRUCTURES
R. H. ANDERSON, C.-C. HUANG, and N. E. BUHOLZ (Lockheed Missiles and Space Co., Inc., Sensor Technology Space Systems Div., Sunnyvale, Calif.) American Astronautical Society, Annual Rocky Mountain Guidance and Control Conference, Keystone, Colo., Jan. 31-Feb. 4, 1981, 18 p. Research supported by the Lockheed Missiles and Space Co. and ARPA. refs
(AAS PAPER 81-022)

The development of a family of laser heterodyne sensors for use in the active control of spacecraft structures is discussed. A coarse system that uses a modulated beam and a high accuracy phase measurement scheme is shown to measure distance with an He-Ne laser absolutely from 1 km down to 0.1 mm. A fine measurement system that uses a multi-state, two-color CO2 laser is shown to produce unambiguous measurements from 12 m down to 0.01 micron resolution over distance up to 100 m. A vibration sensor that uses an He-Ne laser is shown to measure vibrations from dc to kHz with up to 50 channels per detector/laser. The primary concern in the application of the sensors is one of beam direction and integration into the structural system being controlled. D.K.

A81-34234
DEVELOPMENTS TOWARD ACTIVE CONTROL OF SPACE STRUCTURES
R. C. STROUD, M. G. LYONS (Lockheed Research Laboratories, Palo Alto, Calif.), G. A. HAMMA, and S. SMITH Society of Automotive Engineers, Aerospace Congress and Exposition, Los Angeles, Calif., Oct. 13-16, 1980, 20 p. refs
(SAE PAPER 801234)

A review is presented of analytical and experimental research undertaken to develop methods, incorporating elements of control theory and structural dynamics technology, for the active control of flexible space structures. This objective calls for the implementation of a control policy that provides active damping over broad frequency ranges and actively controls selected modes without destabilizing modes not included in the structural idealization. A class of controls emerges from each of these requirements - respectively, a decentralized control using an array of independent, colocated sensor/actuator pairs and direct measurement/feedback, and a centralized control which exploits knowledge of system dynamics and uses coordinated arrays of sensors and actuators that need not be colocated. The verification of these methods by 'minibeam' and 'maxibeam' experiments is detailed. O.C.

A81-34753*
A MORE ACCURATE MODELING OF THE EFFECTS OF ACTUATORS IN LARGE SPACE STRUCTURES
H. B. HABLANI Acta Astronautica, vol. 8, Apr. 1981, p. 361-378. refs
(Contract JPL-955639)

The paper deals with finite actuators. A nonspinning three-axis stabilized space vehicle having a two-dimensional large structure and a rigid body at the center is chosen for analysis. The torquers acting on the vehicle are modeled as antisymmetric forces distributed in a small but finite area. In the limit they represent point torquers which also are treated as a special case of surface distribution of dipoles. Ordinary and partial differential equations governing the forced vibrations of the vehicle are derived by using Hamilton's principle. Associated modal inputs are obtained for both the distributed moments and the distributed forces. It is shown that the finite torquers excite the higher modes less than the point torquers. Modal cost analysis proves to be a suitable methodology to this end. (Author)

A81-37726
INTEGRATED SENSING AND CONTROL SYSTEM FOR A LARGE, DEPLOYABLE, WIDE-FIELD OPTICAL SYSTEM
J. T. WATSON and D. C. EHN (Itek Corp., Lexington, MA) In: Active optical devices and applications; Proceedings of the Seminar, Washington, DC, April 10, 11, 1980. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1980, p. 56-62. refs

The problems of alignment and structural stability associated with very large, multipanel, multisurface optical systems automatically deployable in space are discussed. A sensing system is proposed that measures mirror panel-to-panel mismatch and determines system wavefront as a function of sensor location in the image field. These data are accepted by a central computer control system that deconvolves the control signals. A computer simulation of the sensing and control system is presented, showing the number of iterations required to bring a system into optical adjustment. V.L.

A81-37730
A PERSPECTIVE ON LARGE SPACE STRUCTURE CONTROL
C. S. GREENE and R. E. POPE (Honeywell Systems and Research Center, Minneapolis, MN) In: Active optical devices and applications; Proceedings of the Seminar, Washington, DC, April 10, 11, 1980. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1980, p. 82-86.

The problem of the Large Space Structure is discussed with emphasis on the control system design requirements. The effects of the structure size and increased structural flexibility on the control system design are examined with reference to two design examples, a free-free beam and a large solar array. It is shown that inherent structural damping is a critical parameter in control design and that, given sufficient damping, multi-input/output controllers can be designed which meet the system specifications. A major result is that in general wide-bandwidths components are required to assure the system stability. V.L.

A81-39588* Jet Propulsion Lab., California Inst. of Tech., Pasadena.
ALIGNMENT OF A TWO-BEAM INTERFEROMETER
E. F. TUBBS (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) In: Optical alignment; Proceedings of the Seminar, San Diego, CA, July 29-31, 1980. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1980, p. 123-127. refs
(Contract NAS7-100)

Two beam interferometers have been proposed for space applications such as sensing the shape of a large antenna. Since alignment and adjustment of interferometers have long been considered difficult laboratory tasks, the question of making their operation sufficiently automatic for space applications is a serious one. As a first step in addressing this question certain manual procedures, which may not be well known, have been collected from widely scattered sources. These techniques are illustrated by two examples: (1) the alignment of a Mach-Zehnder interferometer and the adjustment of fringe location. (2) The adjustment of a Michelson interferometer for zero path difference (white light fringes). (Author)

A81-39728
FLEXIBLE SPACECRAFT ATTITUDE CONTROL USING A SIMPLE P + D ALGORITHM
J. FENTON and K. F. GILL (Leeds University, Leeds, England) Aeronautical Journal, vol. 85, May 1981, p. 185-189. refs

An approach to the attitude control of a flexible spacecraft is presented which is based on the selection of the coefficients of the proportional plus derivative (P + D) controller taking into account flexural data from the spacecraft. A controller design in which the P and D matrices are computed from a state control matrix derived from a solution of the matrix Riccati equation is illustrated for a satellite with a solar array mounted at a corner of an asymmetric center body which travels in a sun-synchronous, near-polar circular orbit about the earth and is controlled by orthogonal reaction wheels for each of the three spacecraft orbit reference axes. Results of a simulation study of the applicability, robustness to parameter mismatch and behavior in noise of the controller for the 14th order satellite system are presented which suggest that no major deterioration in craft performance will result from the replacement of the full state vector feedback control algorithm by the much simpler P + D control law in the absence of measurement noise. S.C.S.

A81-42054

ATTITUDE ESTIMATION AND CONTROL OF A FLEXIBLE SPACECRAFT USING INERTIAL AND OPTICAL MEASUREMENTS

D. HORTON, J. FENTON, and K. F. GILL (Leeds University, Leeds, England) Aeronautical Journal, vol. 85, June 1981, p. 240-243.

A method has been developed for the digital simulation of the attitude measurement, estimation, and control of a spacecraft with a flexible solar array in earth orbit. Attitude is measured by three rate-integrating gyros, one on each axis, together with an infrared earth sensor (IRES) on each of the roll and pitch axes, and a sun sensor on the yaw axis. The gyro and IRES measurements are taken and processed continuously, but the sun sensor may only be read intermittently, nominally twice per orbit, owing to the orbital configuration assumed. For the configuration described, with typical levels of sensors and control noise, the rms attitude errors were of the order of 0.3 arcmin in roll and pitch, and 6 arcmin in yaw. The applicability of this approach to future earth resources satellites, which will be required to perform frequent attitude maneuvers and to maintain a given orientation to within a few arcsec, is discussed. P.T.H.

A81-44096#

FINE ATTITUDE CONTROL OF AN EARTH OBSERVATION SATELLITE WITH A DISSYMETRICAL ROTATING SOLAR ARRAY

J. P. CHRETIEN, C. REBOULET, P. RODRIGO (ONERA, Centre d'Etudes et de Recherches de Toulouse, Toulouse, France), and M. MAURETTE (Centre National d'Etudes Spatiales, Toulouse, France) In: Guidance and Control Conference, Albuquerque, NM, August 19-21, 1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1981, p. 121-130. Centre National d'Etudes Spatiales
(Contract CNES-80-0607)
(AIAA 81-1783)

This paper describes the dynamic modelling and fine pointing control system design for the 'SPOT' French earth observation satellites. The dynamic model of the vehicle includes a representation of the flexible solar array by effective mass technique. An on board computer processes the attitude rate informations provided by a gyro package and possibly the measurement of torque around boom axis to provide a very high angular rate accuracy with the help of reaction wheels and solar array drive motor. Several control design techniques are investigated for this multivariable control problem. Performances, including sensitivity to modal data, are checked by extensive simulations. (Author)

A81-44097#

FILTER-ACCOMMODATED OPTIMAL CONTROL OF LARGE FLEXIBLE SPACE SYSTEMS

J. R. SESAK, R. V. HALSTENBERG, Y. CHANG, and M. M. DAVIS (General Dynamics Corp., Convair Div., San Diego, CA) In: Guidance and Control Conference, Albuquerque, NM, August 19-21, 1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1981, p. 177-186. refs
(AIAA 81-1784)

This paper considers the unknown (residual) mode problem of large space system (LSS) control and develops a filter-accommodated optimal control methodology that effectively copes with unknown high-frequency vibration modes. This new, optimal control and estimation algorithm allows the inclusion of designer-specified low-frequency filter dynamics in the control loop such as Tchebycheff or Butterworth, this providing bandwidth control for the closed-loop system. The algorithm allows filter attenuation to begin within the control system bandwidth, the controller working essentially through the filter, and lower-order filters may be used to achieve the required degree of attenuation. (Author)

A81-44098#

EXPERIMENTS ON THE ELECTROSTATIC CONTROL OF A FLEXIBLE MEMBRANE AND THEIR RELATION TO MEMBRANE-ANTENNA FIGURE CONTROL

J. H. LANG (MIT, Cambridge, MA) In: Guidance and Control Conference, Albuquerque, NM, August 19-21, 1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1981, p. 187-191. Research supported by the Fannie and John Hertz Foundation
(Contract DAAG29-78-C-0020)
(AIAA 81-1786)

The stabilization of a noisy two-dimensional distributed-parameter system, with dynamics described by a hyperbolic partial differential equation, is described. The system was a meter-square flexible wire mesh, suspended vertically in tension by rigid boundaries, which supported transverse deflections about a planar equilibrium. These deflections were destabilized by the application of a transverse electrostatic bias; the number of open-loop-unstable deflection modes was adjustable with bias strength. Using information from nine capacitive deflection sensors, a minicomputer manipulated nine electrostatic deflection actuators so as to stabilize the mesh. Up to three open-loop-unstable modes were stabilized. The results of these experiments are encouraging to the design of electrostatically-figured membrane-reflector antennas, and this relation is discussed. (Author)

A81-44099#

ADAPTIVE CONTROL OF FLEXIBLE SPACE STRUCTURES

B. GOVIN, B. CLAUDINON (Matra, S.A., Velizy-Villacoublay, Yvelines, France), and P. DE LARMINAT (Ecole Nationale Superieure de Mecanique, Nantes, France) In: Guidance and Control Conference, Albuquerque, NM, August 19-21, 1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1981, p. 192-199. European Space Research and Technology Centre refs
(Contract ESTEC-4120/79-NL-AK(SC))
(AIAA 81-1787)

This paper is concerned with the analysis and the performance assessment of some existing adaptive control techniques applied to the control of flexible space structures. Application examples are uniform beams (being idealized models of large space structures) and a future geostationary spacecraft having a complex configuration. Several control methods are analysed: model reference technique applied to a simply supported beam vibration control, adaptive modal control through extended Kalman filtering of a free beam, linear quadratic control of geostationary satellite tuned to modal parameters. (Author)

A81-44117#

APPLICATION OF SYSTEM IDENTIFICATION TECHNIQUE TO THE MODELING OF LARGE SPACE STRUCTURES

F. C. TUNG (TRW Defense and Space Systems Group, Redondo Beach, CA) In: Guidance and Control Conference, Albuquerque, NM, August 19-21, 1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1981, p. 333-340. refs
(AIAA 81-1831)

A system identification technique is used to extract a more accurate dynamic model of a large space structure (LSS) from experimental measurements. The approach is to adjust certain critical parameters of the LSS model so that the weighted mean-square distance between the model predicted output and the actual output is minimized. The algorithm allows one to adjust directly the modal parameters in modal representation, or to adjust the physical parameters used in the finite-element model. Computer simulation studies are conducted using a complex large space structure model as an example. Excellent results are obtained for both physical parameters and modal parameters. (Auth

A81-44118#

DIGITAL CONTROL OF 25KW POWER SYSTEM

S. M. SELTZER, J. R. GLAESE (Control Dynamics Co., Huntsville, AL), and H. E. WORLEY In: Guidance and Control Conference, Albuquerque, NM, August 19-21, 1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1981, p. 341-349. refs
(AIAA 81-1832)

This paper describes a digital control system concept that has been proposed for use to control the attitude of the NASA 25 kW Power System now being designed. The design philosophy is patterned after the successful Skylab Pointing and Attitude Control System. The proposed controller consists of a digital filter (to process attitude and rate sensor information), a pointing maneuver control law (to provide desired torque), a CMG steering law, and external disturbance models. A model of the flexible structure was used for the design and is described. In particular, the dynamic effects of sampling upon structural flexibility are analyzed and presented. (Author)

A81-44119#

DYNAMICS AND CONTROL OF PEP/RMS/ORBITER FLEXIBLE MULTIBODY SPACE SYSTEM

J. Y. L. HO, J. A. BILLING-ROSS, and J. IGARASHI (Lockheed Missiles and Space Co., Inc., Space Systems Div., Sunnyvale, CA) In: Guidance and Control Conference, Albuquerque, NM, August 19-21, 1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1981, p. 350-358. refs
(AIAA 81-1834)

The PEP/RMS/ORBITER system is to use the Remote Manipulator System of the shuttle orbiter to locate and maintain the position and orientation of the solar arrays of Power Extension Package. The purpose of this space system is to increase the power level of orbiter by solar energy absorption. Since the PEP solar arrays will be placed at various locations and orientations with respect to the orbiter to accommodate different flight missions, the system physical properties will change from case to case. The attitude of shuttle orbiter is controlled by six Vernier Reaction Control System (VRCS) jets. A digital auto-pilot (DAP) is used to determine the jets selection and firing sequence. The dynamic and control simulation capability is developed to analyze the complex coupling effect between the orbiter rigid body attitude motion and the structural vibration of PEP as well as RMS. The simulation capability developed here is also applicable to other RMS/ORBITER flight operations. (Author)

A81-44120#

STABILITY OF LQG MODAL CONTROL FOR LARGE SPACE STRUCTURES

R. L. KOSUT (Systems Control, Inc., Palo Alto, CA) In: Guidance and Control Conference, Albuquerque, NM, August 19-21, 1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1981, p. 359-364. refs
(AIAA 81-1835)

The stability of LQG modal control (i.e., linear observer based feedback) of large flexible space structures is examined. It is shown that the effect of designing the controller/observer gains on the basis of a reduced order modal representation of the structure is equivalent to a finite gain, linear function, perturbing an LQ modal control (i.e., linear full state feedback of the retained modes). Robustness theorems are utilized to develop frequency domain conditions which guarantee stability. These conditions are applied to the design of a shape/vibration LQG controller using position measurements. (Author)

A81-44124#

ATTITUDE CONTROL OF A FLEXIBLE TRIANGULAR TRUSS IN SPACE

B. WIE and A. E. BRYSON, JR. (Stanford University, Stanford, CA) In: Guidance and Control Conference, Albuquerque, NM, August 19-21, 1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1981, p. 390-396. refs
(AIAA 81-1840)

An infinite-dimensional model for a planar flexible structure, an equilateral triangle truss, is developed in an attempt to find simple flexible structures that can be modeled relatively easily and still be realistic. Exact poles and zeros are determined for transfer functions between colocated control torques and attitude changes in roll, pitch and yaw. Decoupled motion equations about the principal axes are determined, demonstrating that controlling systems with many identical natural frequencies present no inherent difficulties. Simple attitude control logic, based on the concept of alternating poles and zeros along the imaginary axis, is investigated using the exact infinite-dimensional model described by transcendental transfer functions. Although the model investigated is simple, the insights obtained should be useful in developing more complicated structures. D.L.G.

A81-44125*# Houston Univ., Tex.

ALGORITHMS FOR IDENTIFICATION AND ANALYSIS OF LARGE SPACE STRUCTURES

E. D. DENMAN and J. LEYVA-RAMOS (Houston, University, Houston, TX) In: Guidance and Control Conference, Albuquerque, NM, August 19-21, 1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1981, p. 397-400. refs
(Contract NSG-1603)
(AIAA 81-1842)

The identification of the mass, damping and stiffness matrix for the finite-element formulation of a structure will be given. It will be shown that the quadrature integration procedure can be used to find the desired matrices when reasonable assumptions hold. The mass, damping and stiffness matrices of the matrix polynomial are identified by the algorithm. (Author)

A81-44139*# City Univ. of New York, N. Y.

ON-LINE STRUCTURAL PARAMETER IDENTIFICATION

F. E. THAU (New York, City University, New York, NY), R. C. MONTGOMERY, and G. C. HORNER (NASA, Langley Research Center, Hampton, VA) In: Guidance and Control Conference, Albuquerque, NM, August 19-21, 1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1981, p. 530-539. refs
(AIAA 81-1846)

Algorithms are presented for on-line parameter identification of structural dynamic systems. As an example, they are used to calculate the parameters of a modal model of a flexible beam. The algorithms are tested using hardware consisting of a 12 ft. beam with four voice coil actuators and nine noncontacting displacement sensors. They are programmed in a CDC Cyber 175 digital computer which provides input command signals for the actuators, reads the sensor data, and processes the algorithm to calculate consistent estimates of the modal parameters of the beam. Experimental results are compared with those of simulation analysis. (Author)

A81-45547

LARGE SPACE STRUCTURES CONTROL - SYSTEM IDENTIFICATION VERSUS DIRECT ADAPTIVE CONTROL

R. J. BENHABIB and F. C. TUNG (TRW Defense and Space Systems Group, Redondo Beach, CA) In: Joint Automatic Control Conference, San Francisco, CA, August 13-15, 1980, Proceedings. Volume 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1980. 7 p. (TP1-A). refs

Both direct and indirect adaptive controls are applied to a tetrahedral truss structure. It is shown that when the quantities to be controlled are easily observable, both techniques yield acceptable output variable control. Under certain conditions, however, the indirect method obtains better state control performance when the measurement data contains poorly observable modes which must be controlled. It is also shown that, for the case of the tetrahedral truss, identification of such structural properties as cross section and weight can be more effective than the identification of modal parameters. O.C.

A81-45548* Jet Propulsion Lab., California Inst. of Tech., Pasadena.
THE CONTROL AND ESTIMATION OF LARGE SPACE STRUCTURES
C. WEEKS (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) In: Joint Automatic Control Conference, San Francisco, CA, August 13-15, 1980, Proceedings. Volume 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1980. 6 p. (TP1-B).

A shape control or estimation problem for a large space structure can be modeled by a partial differential equation which represents changes in shape with respect to space and time, together with spatially discrete forcing functions or observations which represent the placement of actuators or sensors at discrete points along the structure. The use of Green's functions to convert boundary value problems into integral equations provides a convenient treatment of this mixture of continuous and discrete mathematics. Control and estimation algorithms are developed for the one-dimensional static beam to illustrate this technique. (Author)

A81-45549* City Univ. of New York, N. Y.
ADAPTIVE/LEARNING CONTROL OF LARGE SPACE STRUCTURES - SYSTEM IDENTIFICATION TECHNIQUES
F. E. THAU (New York, City University, New York, NY) and R. C. MONTGOMERY (NASA, Langley Research Center, Hampton, VA) In: Joint Automatic Control Conference, San Francisco, CA, August 13-15, 1980, Proceedings. Volume 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1980. 5 p. (TP1-D). refs

Techniques developed for the control of aircraft under changing operating conditions are used to develop a learning control system structure for a multi-configuration, flexible space vehicle. A configuration identification subsystem that is to be used with a learning algorithm and a memory and control process subsystem is developed. Adaptive gain adjustments can be achieved by this learning approach without prestoring of large blocks of parameter data and without dither signal inputs which will be suppressed during operations for which they are not compatible. The Space Shuttle Solar Electric Propulsion (SEP) experiment is used as a sample problem for the testing of adaptive/learning control system algorithms. O.C.

A81-45550
EFFICIENT TECHNIQUES FOR SYSTEM IDENTIFICATION OF LARGE SPACE STRUCTURES
G. PRADO and R. K. PEARSON (Charles Stark Draper Laboratory, Inc., Cambridge, MA) In: Joint Automatic Control Conference, San Francisco, CA, August 13-15, 1980, Proceedings. Volume 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1980. 5 p. (TP1-F). refs

The prediction error approach to system identification can be used to obtain Auto-Regressive or Auto-Regressive-Moving-Average models of system behavior. These models can be converted to state space representations. Also, they can be used to estimate structural parameters such as modal frequencies and damping ratios because of their improved resolution properties relative to conventional spectrum analysis techniques. Numerically efficient algorithm exist to solve the normal equations which result for either AR or ARMA models. These methods were tested using a realistic model of a structure with 12 vibration modes. (Author)

A81-45555
SYNTHESIS OF LOW ORDER OBSERVERS TO RECONSTRUCT A DESIRED SUBSET OF STATES OR MODES OF A HIGH ORDER LINEAR SYSTEM
M. K. MACKAY (TRW Defense and Space Systems Group, Redondo Beach, CA) In: Joint Automatic Control Conference, San Francisco, CA, August 13-15, 1980, Proceedings. Volume 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1980. 8 p. (TP6-C).

The considered investigation is concerned with the problem of synthesizing low order observers that will extract selected vibrational modes from the sensed motions of a linear structure. The possibility of obtaining large reductions in the required observer dimension was first noted by Luenberger (1966). In the current investigation Luenberger's result has been improved upon, in that, a single observer of order n/m-1 is synthesized that will give both modal coordinates. A method is demonstrated for constructing low order modal observers. The results show that observers having orders significantly lower than conventional Luenberger Observers and Full State Observers are realizable with only modest requirements on the system, namely, observability and linear independence of sensor measurements. The amount of order reduction that is possible is simply a function of the number of sensors that are implemented. G.R.

A81-45564* Jet Propulsion Lab., California Inst. of Tech., Pasadena.
MODEL ERROR ESTIMATION FOR LARGE SPACE SYSTEMS
G. RODRIGUEZ (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) In: Joint Automatic Control Conference, San Francisco, CA, August 13-15, 1980, Proceedings. Volume 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1980. 12 p. (FA1-B). refs
(Contract NAS7-100)

In-flight estimation of large structure model errors may have to be carried out in order to detect inevitable deficiencies in large structure controller/estimator models. These error estimates can most efficiently be obtained by the minimization of a quadratic functional of the model errors and on the subsequent analysis of the resulting optimal model error estimates. An integral operator approach to estimation leads to a geometrical interpretation of the model error estimation process. One of the significant insights gained with this interpretation is that the actual but unknown model errors can be decomposed as the sum of two distinct components that are orthogonal in some sense. One of these components is a so-called minimal error vector that retains many of the significant dynamics of the actual errors. The basic ideas in the model error estimation approach are first set forth with a two-dimensional analogy that has most of the essential features of the general estimation problem. The generalized results are then established and their application to a reference large structure model illustrated. (Author)

A81-45565
GUARANTEED ERROR ESTIMATION/IDENTIFICATION AND ITS APPLICATIONS TO LARGE FLEXIBLE SPACE STRUCTURES
Y. W. A. WU (Martin Marietta Aerospace, Denver, CO) In: Joint Automatic Control Conference, San Francisco, CA, August 13-15, 1980, Proceedings. Volume 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1980. 7 p. (FA1-C). refs

An adaptive control scheme and its applications to large flexible structures are proposed, for which a guaranteed error estimation and parameter identification scheme has been developed that will simultaneously identify system parameters and estimate the state variables that provide adaptive feedback. It is shown that, for a class of large space structures, the control mode frequencies can be identified while controlling the system. Parameter identification can be carried out either through the use of N sensors or the minimum set of sensors. The effectiveness of the method is demonstrated by means of simulation studies for the yaw attitude control of a representative large spacecraft. O.C.

A81-45566

DECENTRALIZED ELASTIC BODY AND RIGID BODY CONTROL BY MODEL ERROR SENSITIVITY SUPPRESSION

J. R. SESAK and R. V. HALSTENBERG (General Dynamics Corp., Convair Div., San Diego, CA) In: Joint Automatic Control Conference, San Francisco, CA, August 13-15, 1980, Proceedings. Volume 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1980. 4 p. (FA1-D).

A novel application is presented for the Model Error Sensitivity Suppression algorithm (MESS) in which decentralized altitude and flexible body control systems have overlapping bandwidths but avoid destructive interference. The decentralized capabilities of the algorithm allow advantage to be taken of distributed microprocessing. The advent of large, orbitally-assembled space structures having many closely-spaced, low-frequency structural oscillation modes demands control techniques of this type. O.C.

A81-45576

A UNIFIED APPROACH TO THE DESIGN OF LARGE SPACE STRUCTURE CONTROL SYSTEMS

R. P. IWENS, R. J. BENHABIB, and R. L. JACKSON (TRW Defense and Space Systems Group, Redondo Beach, CA) In: Joint Automatic Control Conference, San Francisco, CA, August 13-15, 1980, Proceedings. Volume 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1980. 9 p. (FP1-A). refs

A robust design methodology is presented that assures stability of large space structure control systems using multiple actuators and sensors for active structure control. The method is based on the positivity of operators. Exact knowledge of the modal data describing the structure is not required, and system stability can be assured independent of modal truncation. The design accounts for sensor and actuator dynamics, and allows the presence of zero frequency rigid body modes. The controller may contain dynamic elements such as state estimators and other compensators. (Author)

A81-45577* Vigyan Research Associates, Inc., Hampton, Va.

A TWO-LEVEL CONTROLLER DESIGN APPROACH FOR LARGE SPACE STRUCTURES

S. M. JOSHI (Vigyan Research Associates, Inc., Hampton, VA) and N. J. GROOM (NASA, Langley Research Center, Hampton, VA) In: Joint Automatic Control Conference, San Francisco, CA, August 13-15, 1980, Proceedings. Volume 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1980. 7 p. (FP1-B). refs

A controller design approach is proposed for large space structures (LSS) using an Annular Momentum Control Device (AMCD). The controller consists of a primary attitude controller and a secondary or modal damping enhancement controller. It is proved that the LSS/AMCD system using the proposed damping enhancement controller is stable in the sense of Lyapunov regardless of the number of modes in the model and without the necessity of precise knowledge of the modal frequencies and mode shapes. Numerical results obtained for the secondary controller design for a large thin flat plate indicate that the proposed method can yield satisfactory damping enhancement with small weight penalty. (Author)

A81-45578

PARETO OPTIMAL VIBRATION DAMPING OF LARGE SPACE STRUCTURES WITH MODAL DASHPOTS

R. B. PRESTON (USAF, Rocket Propulsion Laboratory, Edwards AFB, CA) and J. G. LIN (Charles Stark Draper Laboratory, Inc., Cambridge, MA) In: Joint Automatic Control Conference, San Francisco, CA, August 13-15, 1980, Proceedings. Volume 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1980. 6 p. (FP1-C). refs

The purpose of this paper is to report an application of multiple-objective optimization to efficient control of large space structures. The 'modal dashpot' design philosophy for active vibration control is employed in this application. A bi-objective optimization program is developed for numerically generating Pareto optimal designs that minimize feedback gains and maximize the damping of critical vibration modes. Numerical results on a twelve-mode finite-element model of an example flexible tetrahedral structure are presented. These include the Pareto optimal designs and the robustness of such modal dashpots to violations of the underlying design assumptions (e.g., parameter variation, spillover, noncollocation). Results show that spillover and noncollocation together cause the modal dashpots to destabilize the tetrahedral structure. (Author)

A81-45579* Rensselaer Polytechnic Inst., Troy, N. Y.

FINITE ELEMENT MODELS AND FEEDBACK CONTROL OF FLEXIBLE AEROSPACE STRUCTURES

M. J. BALAS (Rensselaer Polytechnic Institute, Troy, NY) In: Joint Automatic Control Conference, San Francisco, CA, August 13-15, 1980, Proceedings. Volume 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1980. 10 p. (FP1-D). refs

(Contract NAS9-16053)

Large flexible aerospace structures, such as the solar power satellite, are distributed parameter systems with very complex continuum descriptions. This paper investigates the use of finite element methods to produce reduced-order models and finite dimensional feedback controllers for these structures. The main results give conditions under which stable control of the finite element model will produce stable control of the actual structure. (Author)

A81-45580

ROBUST COLOCATED CONTROL FOR LARGE FLEXIBLE SPACE STRUCTURES

A. ARBEL and N. K. GUPTA (Systems Control, Inc., Palo Alto, CA) In: Joint Automatic Control Conference, San Francisco, CA, August 13-15, 1980, Proceedings. Volume 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1980. 6 p. (FP1-E). refs

The closed-loop stability properties of a large flexible space structure with colocated actuators and sensors are examined. It is shown that when the output feedback gain matrix is chosen as symmetric negative definite the resulting closed-loop system is stable. It is further shown that these stability properties are robust with respect to truncated modes and parameter variations. (Author)

A81-45785*# Howard Univ., Washington, D. C.

THE DYNAMICS OF LARGE FLEXIBLE EARTH POINTING STRUCTURES WITH A HYBRID CONTROL SYSTEM

P. M. BAINUM, R. KRISHNA, and V. K. KUMAR (Howard University, Washington, DC) American Astronautical Society and American Institute of Aeronautics and Astronautics, Astrodynamics Specialist Conference, Lake Tahoe, NV, Aug. 3-5, 1981, AAS 21 p. refs

(Contract NSG-1414)

(AAS PAPER 81-122)

The dynamics and control of large flexible structures nominally oriented along the local horizontal are analyzed. Orientation and shape control is assumed to be provided by a hybrid system consisting of a passive spring loaded gimballed dumbbell damper in addition to active point thrusters. In addition to the passive damping capability, the dumbbell, through attachment at the center of mass of the main structure, also provides a favorable composite moment of inertia ratio required for gravitational stabilization. The hybrid system is seen to generally result in improved transient responses to initial perturbations in orientation and modal shape functions, while requiring less force impulse than that for the active system operating alone. (Author)

A81-45790#

AN EFFICIENT TOOL FOR THE PROPAGATION AND CONTROL OF GEOSYNCHRONOUS ORBITS

C. C. CHAO and J. M. BAKER (Aerospace Corp., Astrodynamics Dept., Los Angeles, CA) American Astronautical Society and American Institute of Aeronautics and Astronautics, Astrodynamics Specialist Conference, Lake Tahoe, NV, Aug. 3-5, 1981, AAS 35 p. refs

(Contract F04701-80-C-0081)

(AAS PAPER 81-129)

The considered study is concerned with the development of an orbit ephemeris propagator that is useful for low inclination, low eccentricity geosynchronous satellite orbits. A semianalytical technique is used in which the perturbations due to earth zonal and tesseral harmonics to 4th order, sun-moon attractions, and solar radiation pressure are averaged over one satellite revolution. The averaged element rates are then numerically integrated with step sizes of one day, allowing for rapid, yet accurate ephemeris prediction over years of mission duration. The propagator contains algorithms for automatically and optimally controlling longitude of ascending node, inclination and argument of perigee. Typical stationkeeping requirements for these three parameters are 2, 50, and 8 m/sec per year, respectively. G.R.

A81-45810#

DYNAMICAL EQUATIONS OF A FREE-FREE BEAM SUBJECT TO LARGE OVERALL MOTIONS

R. A. LASKIN, P. W. LIKINS, and R. W. LONGMAN (Columbia University, New York, NY) American Astronautical Society and American Institute of Aeronautics and Astronautics, Astrodynamics Specialist Conference, Lake Tahoe, NV, Aug. 3-5, 1981, AAS 21 p. refs

(AAS PAPER 81-119)

Ordinary differential equations of motion of a free-free beam subject to large overall motions are derived. Specialization is then made to nominal motions of interest to the field of satellite dynamics and control. When the beam is spinning, certain nonlinear elastic effects as well as kinematical effects due to the rotation are seen to come into play. (Author)

A81-45811*# Lockheed Missiles and Space Co., Palo Alto, Calif.

SIMULATION OF LARGE MOTIONS OF NONUNIFORM BEAMS IN ORBIT. I - THE CANTILEVER BEAM

D. A. LEVINSON (Lockheed Research Laboratories, Palo Alto, CA) and T. R. KANE (Stanford University, Stanford, CA) American Astronautical Society and American Institute of Aeronautics and Astronautics, Astrodynamics Specialist Conference, Lake Tahoe, NV, Aug. 3-5, 1981, AAS 51 p. Research supported by the Lockheed Missiles and Space Co. refs

(Contract NAG1-97)

(AAS PAPER 81-120)

An algorithm is developed for producing numerical simulations of large motions of a nonuniform cantilever beam in orbit. Special emphasis is given to the effective formulation of equations of motion and to the use of the finite element method to construct modal functions. Finite element methods are used to generate modal functions in such a way as to permit a particularly harmonious relationship to be established between the disciplines of rigid body dynamics and structural analysis. Sufficient information is provided to enable a reader to create, with relatively little effort, his own simulation program; simulation results are reported, both to provide check cases for other investigators and to illustrate certain important facets of the behavior of flexible spacecraft. C.R.

A81-45812*# Stanford Univ., Calif.

SIMULATION OF LARGE MOTIONS OF NONUNIFORM BEAMS IN ORBIT. II - THE UNRESTRAINED BEAM

T. R. KANE (Stanford University, Stanford, CA) and D. A. LEVINSON (Lockheed Research Laboratories, Palo Alto, CA) American Astronautical Society and American Institute of Aeronautics and Astronautics, Astrodynamics Specialist Conference, Lake Tahoe, NV, Aug. 3-5, 1981, AAS 45 p. Research supported by the Lockheed Missiles and Space Co.

(Contract NAG1-97)

(AAS PAPER 81-121)

An algorithm is developed for the numerical simulation of large motions of an unrestrained, nonuniform beam in orbit. Explicit provisions are made for the accommodation of general, physically significant initial conditions and for the specification of control forces in practical terms. The evaluation of certain constants that appear in the equations of motion is considered, the finite element method being used for this purpose. The importance of initial conditions in the study of spacecraft motions is stressed. C.R.

A81-45843*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

COMMAND PROFILE FOR GALILEO SCAN PLATFORM CONTROL

G. K. MAN and W. G. BRECKENRIDGE (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) American Astronautical Society and American Institute of Aeronautics and Astronautics, Astrodynamics Specialist Conference, Lake Tahoe, NV, Aug. 3-5, 1981, AAS 15 p. NASA-supported research.

(AAS PAPER 81-190)

A recursive command profile is developed for the control of a two-degree-of-freedom scan platform mounted on a flexible structure. Perfect sensors and actuators are assumed for development and testing, and structural vibrations are minimized by actuator torque commands following a smooth torque-time profile. The integral of the smooth torque profile, the rate profile, is recursively generated by a piecewise constant second derivation, and the torque applied by the closk actuator is divided into three components. Results show that the smooth platform motion in response to the command profiles is what the Galileo control systems needs to avoid stator structural vibrations. Position, rate and acceleration profiles are also presented, and the resulting motion of the scan platform in response to command profiles is illustrated. D.L.G.

A81-45847#

A COMPARISON OF CONTROL TECHNIQUES FOR LARGE FLEXIBLE SYSTEMS

L. MEIROVITCH, H. BARUH, and H. OZ (Virginia Polytechnic Institute and State University, Blacksburg, VA) American Astronautical Society and American Institute of Aeronautics and Astronautics, Astrodynamics Specialist Conference, Lake Tahoe, NV, Aug. 3-5, 1981, AAS 26 p. refs

(AAS PAPER 81-195)

Two approaches to the active control of large flexible systems are compared, namely, coupled controls and independent modal-space controls. The difference between the two approaches is in their requirement on the number of actuators. The two methods are compared qualitatively, from design and computational viewpoints and quantitatively, through the work done, performance index and spillover effects. The comparison shows the independent modal-space control method to possess many advantages over coupled controls, as it permits easier design and implementation and it requires less computational effort and less control energy for implementation. (Author)

A81-45848#
ASPECTS OF THE DEGREE OF CONTROLLABILITY - APPLICATIONS TO SIMPLE SYSTEMS
R. E. LINDBERG (U.S. Navy, Naval Research Laboratory, Washington, DC) and R. W. LONGMAN (Columbia University, New York, NY) American Astronautical Society and American Institute of Aeronautics and Astronautics, Astrodynamics Specialist Conference, Lake Tahoe, NV, Aug. 3-5, 1981, AAS 22 p. refs
(AAS PAPER 81-196)

The degree of controllability of a control system is considered as an appropriate criterion for ranking the effectiveness of alternative control system configurations. Several aspects of the degree of controllability are investigated by considering simple systems for which the exact value of the degree of controllability can be readily obtained. The relation of the degree of controllability to system stability is identified. Three second order systems, comprising the types of modes occurring in modal representations of typical large flexible space structures, are then considered: the harmonic oscillator, the damped harmonic oscillator, and the double integral plant. The accuracy of the approximation method is examined, and the possibility of eliminating the recovery time specification from the problem by obtaining approximate linear relations is discussed. The impact of normalization of the state on the degree of controllability of the system is also considered. J.F.

A81-45849#
LOW ORDER CONTROLLERS FOR FLEXIBLE SPACECRAFT
J. R. VELMAN (Hughes Aircraft Co., Space Flight Mechanics Dept., Los Angeles, CA) American Astronautical Society and American Institute of Aeronautics and Astronautics, Astrodynamics Specialist Conference, Lake Tahoe, NV, Aug. 3-5, 1981, AAS 22 p. Research supported by the Hughes Aircraft Co. refs
(AAS PAPER 81-197)

In the design of flexible spacecraft controllers it is shown that there is a limitation on the ability of a linear controller to influence a certain mode without having a strong influence on modes of a higher frequency. The use of a low order filter to estimate an approximation to a desired linear function of state in conjunction with a high order design model is discussed. State feedback control laws which can be estimated with controllers of any order are examined for the special case when the plant is a lightly damped structure with no gyroscopic coupling. The filter output, as a function of state, is characterized in terms of the transfer function of the estimator, permitting the use of well developed classical design methods. The sensor noise transmission and disturbance force transmission properties of the filter are considered, as well as the classical gain and phase margins. For high levels of performance, more powerful methods are required for determining state feedback laws for high order systems which are compatible with low order control law estimators. J.F.

A81-45850#
OPTIMAL REGULATION WITHIN SPATIAL CONSTRAINTS - AN APPLICATION TO FLEXIBLE STRUCTURES
E. G. TAYLOR (USAF, Space Div., Los Angeles, CA) American Astronautical Society and American Institute of Aeronautics and Astronautics, Astrodynamics Specialist Conference, Lake Tahoe, NV, Aug. 3-5, 1981, AAS 35 p. refs
(AAS PAPER 81-198)

An examination is conducted of a family of regulator based controller designs as applied to a representative flexible spacecraft mode. The traditional optimal gain/estimator architecture is modified with the aid of an approach which takes into account knowledge of satellite structural response characteristics and insights from linear algebra, state space canonical forms, and singular perturbation theory. The modifications attempt to provide corrections concerning two drawbacks experienced in connection with regulator implementation. One of the drawbacks is related to the sensitivity of regulator designs to the process which converts the distributed parameter structural description to a finite dimensional controller design model. The second drawback is connected with the high dimension of the observer which is needed to provide full state feedback. According to the modifications the controller input and output are constrained in the spatial domain, and the residual modes are explicitly accounted for in the controller. G.R.

A81-45851#
SPACE STRUCTURE CONTROL VIA A FREQUENCY-SHAPED KTC APPROACH
R. D. HEFNER and W. P. HALLMAN (Aerospace Corp., Los Angeles, CA) American Astronautical Society and American Institute of Aeronautics and Astronautics, Astrodynamics Specialist Conference, Lake Tahoe, NV, Aug. 3-5, 1981, AAS 15 p. Research supported by the Aerospace Corp. refs
(AAS PAPER 81-199)

This paper discusses a linear control design technique for minimizing the effects of the control on the uncompensated flexible modes of the system. The approach involves directly building preselected frequency domain characteristics into the solutions of the Kelvin-Tait-Chataev (KTC) stability equations. The resulting constraint equations are cast into a functional minimization framework and parameter optimization techniques are used to determine a solution. (Author)

A81-45852*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
TUNED FEEDBACK DAMPING WITH APPLICATION TO THE GALILEO SPACECRAFT
G. A. MACALA (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) American Astronautical Society and American Institute of Aeronautics and Astronautics, Astrodynamics Specialist Conference, Lake Tahoe, NV, Aug. 3-5, 1981, AAS 25 p. refs
(Contract NAS7-100)
(AAS PAPER 81-200)

An adaptive controller has been developed which uses phase-locked-loops as the adaptive devices. The controller provides active damping to systems which have their underdamped frequencies known only to within a particular range (e.g. plus or minus 20% uncertainty). The design and analysis of the controller is presented along with an application of such a controller to the scan platform pointing system of the Galileo spacecraft, a system with sensors and actuators separated by flexible structure. (Author)

A81-46277#
OPTIMAL FEEDBACK SLEWING OF FLEXIBLE SPACECRAFT
J. A. BREAKWELL (Lockheed Missiles and Space Co., Inc., Palo Alto, CA) Journal of Guidance and Control, vol. 4, Sept.-Oct. 1981, p. 472-479.

A method is presented for maneuvering a flexible spacecraft from one position to another while leaving an arbitrary number of bending modes inactive at the end of the maneuver. The method combines standard fixed-time linear quadratic Gaussian regulator control theory with a modal decomposition of a flexible body. Further features of the method are that it uses minimum control effort and it can be converted to a feedback form to deal with random disturbances and parameter uncertainties. Several examples are given to demonstrate the efficacy of the method, and results from a hardware experiment are presented. (Author)

A81-46278#
ROBUST COLOCATED CONTROL FOR LARGE FLEXIBLE SPACE STRUCTURES
A. ARBEL (Systems Control, Inc., Palo Alto, CA) and N. K. GUPTA (Integrated Systems, Inc., Palo Alto, CA) Journal of Guidance and Control, vol. 4, Sept.-Oct. 1981, p. 480-486. Research supported by the Systems Control, Inc. refs
(Contract N00014-77-C-0247)

Closed-loop performance properties of a large flexible space structure with colocated actuators and sensors are examined. It is shown that when an output feedback gain matrix is chosen as symmetric negative-definite, a linear quadratic optimization (LQ) problem can be stated and solved in closed form via an inverse optimal control formulation. The known properties of this LQ problem guarantees the stability of the closed-loop system. It is further shown that the closed-loop system remains stable in the presence of certain parameter variations. These robustness properties include also the effect of truncated modes on stability. The understanding of the specific output feedback controller, offered through the inverse optimal control solution, lends itself to a design procedure that selects the output feedback gain matrix in an iterative manner. (Author)

A81-46284#

SENSITIVITY OF MODAL-SPACE CONTROL TO NONIDEAL CONDITIONS

W. L. HALLAUER, JR. and J.-F. M. BARTHELEMY (Virginia Polytechnic Institute and State University, Blacksburg, VA) Journal of Guidance and Control, vol. 4, Sept.-Oct. 1981, p. 564-566. refs

Much of a previous study of modal-space control, with application proposed for flexible space structures, has been based on certain ideal conditions, including the knowledge of the exact modal parameters of the structure to be controlled, and the availability of an essentially unlimited number of control actuators. Since the ideal conditions generally do not exist in reality, the practical value of modal-space control depends on its effectiveness under more realistic, nonideal conditions. An investigation is conducted, in which attention is given to the physical and modal equations of motion, the modal-space control with a limited number of actuators, the consequences of imperfect modal response measurements, and the consequences of inaccurate modal information. It is found that the most important factor limiting the effectiveness of modal-space control is control spillover into the residual modes which occurs because there are fewer control actuators than modes. G.R.

A81-47315

MAGNETICALLY-SUSPENDED MOMENTUM GYRO FOR ORBITAL STATIONS ATTITUDE CONTROL

N. N. SHEREMETEVSKII, D. M. VEINBERG, V. P. VERESHCHAGIN, and N. N. DANILOV-NITUSOV International Astronautical Federation, International Astronautical Congress, 32nd, Rome, Italy, Sept. 6-12, 1981, 6 p.

(IAF PAPER 81-50)

Electromagnetic bearings of a one-axis momentum gyroscope designed for attitude control of heavy orbital stations are discussed. Effects of the rotor gyroscope and elastic properties, nonlinearities and cross couplings in the magnetic system under radial bearing control are taken into account. A precession velocity signal to increase bearing capacity under dynamic loads is proposed, and prototype examinations are conducted to confirm the feasibility of the application of electromagnetic bearings in momentum gyros for heavy orbital stations. Results show that rotor deflectors arising under the gyro-unit do not exceed 30% of the rated gap, and an investigation of bearing main parameters indicates that the cross coupling coefficient varies from 0.1 to 0.4 depending on the number of poles in the magnetic system. In addition, the lower limit of the coefficient corresponds to the eight-pole magneto-decoupled system, while the upper limit corresponds to the multi-pole magneto-coupled system. D.L.G.

A81-47318

PRECISE ORIENTATION OF MULTIBEAM SATELLITE

S. H. MARX (Ford Aerospace and Communications Corp., Western Development Laboratories Div., Palo Alto, CA) International Astronautical Federation, International Astronautical Congress, 32nd, Rome, Italy, Sept. 6-12, 1981, 12 p. Research sponsored by the International Telecommunications Satellite Organization.

(IAF PAPER 81-53)

The Intelsat V satellite is a multibeam/multiantenna RF satellite, 3 axis, stabilized in orbit. The primary references for the attitude control system is an earth sensor for pitch and roll and a combination of sun sensors for yaw. This paper describes the geometric relationship between the attitude control sensors and all the different RF antennas and the methods used to align each of the elements. The second part of the paper describes the actual testing used in a 1 g environment to get as close as possible to an end-to-end verification of the alignment methods. The final section of the paper gives the initial onorbit results and their correlation with the ground-based measurements. Initial results of this data seem to indicate that the overall onground tests, in most cases, present a rather pessimistic performance prediction. (Author)

A81-47461

A REVIEW OF THE ATTITUDE CONTROL OF COMMUNICATION SATELLITES

C. A. MARKLAND (ESA, European Space Research and Technology Centre, Noordwijk, Netherlands) International Astronautical Federation, International Astronautical Congress, 32nd, Rome, Italy, Sept. 6-12, 1981, 25 p. refs

(IAF PAPER 81-344)

This paper reviews the development of communication satellites and their attitude control systems from the earliest passive vehicles to the present day. Satellite configurations are presented first, including the development in both the Western countries and the Soviet Union. Then a more specialized review is given of the development of attitude control systems from spin stabilization through dual-spin and momentum bias, to zero momentum. Finally, research problems arising in the control of future missions are discussed. (Author)

A81-47463

ON THE CONTROL OF THE SPACE SHUTTLE BASED TETHERED SYSTEMS

V. J. MODI (British Columbia, University, Vancouver, Canada), A. K. MISRA (McGill University, Montreal, Canada), C.-F. GENG, and D. M. XU International Astronautical Federation, International Astronautical Congress, 32nd, Rome, Italy, Sept. 6-12, 1981, 14 p. Natural Sciences and Engineering Research Council of Canada refs

(Contract NSERC-A-2181; NSERC-A-0967)

(IAF PAPER 81-347)

Spatial dynamics of the Space Shuttle based tethered subsatellite system is investigated using a relatively simple nonlinear model that accounts for the rotating oblate atmosphere. Results show that the normally unstable retrieval maneuver can be stabilized satisfactorily using a nonlinear tether tension control strategy which depends on the tether length, its variation with time and pitch rate. Effectiveness of the control is illustrated through an example involving a 100 km tether supporting a proposed subsatellite for charting the earth's magnetic field. (Author)

A81-47467*

A CLASS OF STABLE, ROBUST FEEDBACK CONTROLLERS FOR LARGE SPACE STRUCTURES

S. M. JOSHI (Old Dominion University Research Foundation, Hampton, VA) International Astronautical Federation, International Astronautical Congress, 32nd, Rome, Italy, Sept. 6-12, 1981, 10 p. refs

(Contract NAG1-102)

(IAF PAPER 81-351)

A two-level control system design is considered for large space structures, which consists of a primary and a secondary controller. The secondary or damping enhancement controller is shown to be stable and robust, even when time-invariant nonlinearities are present in the actuators and/or sensors. The use of Annular Momentum Control Devices (AMCD's) is also considered for secondary control. The primary attitude controller using collocated torque actuators and attitude and rate sensors is stable and robust. The effect of actuator/sensor dynamics on the stability of the primary and secondary controllers is considered. The AMCD's used for secondary control actuation can also be used for the primary controller. (Author)

A81-47485
A DYNAMICAL FORMULATION FOR MULTIFLEXIBLE CONTROLLED SPACECRAFT SIMULATION
G. CORRADO and M. T. RAVAZZOTTI (Aeritalia S.p.A., Turin, Italy) International Astronautical Federation, International Astronautical Congress, 32nd, Rome, Italy, Sept. 6-12, 1981, 14 p. refs
(IAF PAPER 81-379)

The dynamic behavior of highly flexible, rotating spacecraft is described by a method which does not require any particular approximation and is not limited to any particular arrangement of the bodies constituting the system. The analytical technique is based on the formalism of the DISCOS computer program (Bodley, 1978), a powerful tool for the dynamic simulation of complex spacecraft. The state equations, described in a general format, are applicable to any complex spacecraft under any environmental load. The approach takes into account the distributed flexibility, the relative motion of the bodies, the automatic coupling of the momentum wheels, the system control laws, and their interaction with the structure. Synthesis and analysis of the linearized system are used to solve time and frequency equations. The required computing times for different program options are listed, along with the number of equations and the integration step size. A block diagram of the DISCOS package structure is given, showing the development from problem definition to simulation results.
J.F.

A81-47986*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
KINESTHETIC COUPLING BETWEEN OPERATOR AND REMOTE MANIPULATOR
A. K. BEJCZY (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) and J. K. SALISBURY, JR. (Stanford University, Stanford, CA) In: Advances in computer technology - 1980. Volume 1 - Proceedings of the International Computer Technology Conference, San Francisco, CA, August 12-15, 1980. New York, American Society of Mechanical Engineers, 1980, p. 197-211. refs
(Contract NAS7-100)

A universal force-reflecting hand controller has been developed which allows the establishment of a kinesthetic coupling between the operator and a remote manipulator. The six-degree-of-freedom controller was designed to generate forces and torques on its three positional and three rotational axes in order to permit the operator to accurately feel the forces encountered by the manipulator and be as transparent to operate as possible. The universal controller has been used in an application involving a six-degree-of-freedom mechanical arm equipped with a six-dimensional force-torque sensor at its base. In this application, the hand controller acts as a position control input device to the arm, while forces and torques sensed at the base of the mechanical hand back drive the hand controller. The positional control relation and the back driving of the controller according to inputs experienced by the force-torque sensor are established through complex mathematical transformations performed by a minicomputer. The hand controller is intended as a development tool for investigating force-reflecting master-slave manipulator control technology.
A.L.W.

N81-20455 Virginia Polytechnic Inst. and State Univ., Blacksburg.
A GENERAL DYNAMIC SYNTHESIS FOR COMPLEX STRUCTURES COMPOSED OF SUBSTRUCTURES Ph.D. Thesis
A. L. HALE 1980 166 p
Avail: Univ. Microfilms Order No. 8105331

A general substructure synthesis method is developed for the dynamic analysis of complex flexible structures. In the synthesis method, substructures may be modeled by either distributed-parameter or discrete mathematical models. The motion of each distributed substructure is represented by a given number of substructure admissible functions. Substructure admissible functions are often low-order polynomial and hence computationally easy to work with. To represent the motion of each discrete substructure, the concept of admissible vectors is introduced. Admissible vectors represent the discrete counterpart of admissible functions for distributed substructures and they can be generated for each substructure by discretizing, i.e., sampling in space, admissible functions for a similar distributed substructure. The otherwise disjoint substructures are connected together to form a whole structure by imposing approximate geometric compatibility conditions by means of the method of weighted residuals.
Dissert. Abstr.

N81-23163# Messerschmidt-Boelkow G.m.b.H., Munich (West Germany).
APPLICATION OF SYMPHONIE EXPERIENCES IN FOLLOW-UP PROJECTS AT MBB
W. GOESCHEL and J. HELLWEG *In* CNES Symphonie Symp. p 835-850 1980
Avail: NTIS HC A99/MF A01

The technology of three axis stabilization and bipropellant propulsion systems for Symphonie as well as improvements in follow on projects are described. The three axis attitude control system of Intelsat V is a derivation of the Symphonie stabilization system, improved for higher accuracies and adapted to a heavy satellite with large flexible solar arrays. The Symphonie bipropellant technology is applied in the Galileo project, a joint US-German program for the exploration of Jupiter. The Symphonie 10 and 400 N engines are used with small modifications, but are now served by a common feed and tank system (unified system). The direct broadcasting satellite TV-SAT uses Symphonie technology to a large extent. Three axis attitude control, which has to assure very high antenna pointing accuracies, is still based on the Symphonie bias momentum principle with ball bearing supported flywheels. Optical sensor technology is also derived from Symphonie.
Author (ESA)

N81-23183# Draper (Charles Stark) Lab., Inc., Cambridge, Mass.
ACOSS SIX (ACTIVE CONTROL OF SPACE STRUCTURES) Interim Report, 14 Feb. - 15 Jul. 1980
R. R. STRUNCE, J. G. LIN, D. R. HEGG, R. K. PEARSON, and J. P. GOVIGNON Jan. 1981 162 p refs
(Contract F30602-80-C-0096; ARPA ORDER 3654; AF PROJ. 3654)
(AD-A097206; R-1404; RADC-TR-80-377) Avail: NTIS HC A08/MF A01 CSCL 22B

The theoretical research documented in this report addresses control law design methodologies relevant to control of large space structures. Emphasis is on model reduction, design methods for determining reduced-order compensators, and criteria for determining overall closed-loop system stability. A simple but realistic evaluation model (Draper Model no. 2) is presented which will be used to assess performance and sensitivity of the various active structural control methods.
GRA

N81-24166*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
DISTRIBUTED CONTROL OF LARGE SPACE STRUCTURES
D. B. SCHAECHTER 1 May 1981 95 p refs Sponsored by NASA
(NASA-CR-164365; JPL-PUB-81-15) Avail: NTIS HC A05/MF A01 CSCL 22B

Theoretical developments and the results of laboratory experiments are treated as they apply to active attitude and vibration control, as well as static shape control. Modern control theory was employed throughout as the method for obtaining estimation and control laws.
T.M.

N81-25122*# Rensselaer Polytechnic Inst., Troy, N. Y. Dept. of Electrical, Computer and Systems Engineering.
SPS FLEXIBLE SYSTEM CONTROL ASSESSMENT ANALYSIS Final Report
M. J. BALAS 15 Mar. 1981 163 p refs
(Contract NAS9-16053)
(NASA-CR-160962) Avail: NTIS HC A08/MF A01 CSCL 22B

Active control of the Satellite Power System (SPS0, a large mechanically flexible aerospace structure is addressed. The control algorithm is the principle component in the feedback link from sensors to actuators. An analysis of the interaction of the SPS structure and its active control system is presented. E.A.K.

N81-25143*# Vigyan Research Associates, Inc., Hampton, Va.
A CONTROLLER DESIGN APPROACH FOR LARGE FLEXIBLE SPACE STRUCTURES Final Report, 22 Feb. 1980 - 30 Apr. 1981
S. M. JOSHI May 1981 53 p refs
(Contract NAS1-16126)
(NASA-CR-165717) Avail: NTIS HC A04/MF A01 CSCL 22B

A controller design approach for large space structures is presented, which consists of a primary attitude controller and a secondary or damping enhancement controller. The secondary controller, which uses several Annular Momentum Control Device (AMCD's), is shown to make the closed loop system asymptotically stable under relatively simple conditions. The primary controller using torque actuators (or AMCD's) and colocated attitude and rate sensors is shown to be stable. It is shown that the same AMCD's can be used for simultaneous actuation of primary and secondary controllers. Numerical results are obtained for a large, thin, completely free plate model. Author

N81-25758# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
MODERN OPTIMAL CONTROL METHODS APPLIED IN ACTIVE CONTROL OF A TETRAHEDRON M.S. Thesis
A. M. JANISZEWSKI Dec. 1980 109 p refs
(AD-A094766; AFIT/GS/AA/80D-2) Avail: NTIS HC A06/MF A01 CSCL 12B

Modern optimal control methods are applied to a lumped mass model of a tetrahedron. The four unit masses of this model are interconnected by isotropic massless rods which are capable of axial deformation only (no bending). System control is achieved via collocated sensor/actuator pairs at three of the four masses. Pointing accuracy at the fourth mass is used as a figure of merit in determining the effectiveness of the controller. A prescribed line of sight response is established as a goal for successful control. The controller is developed using linear optimal techniques which produce feedback gains proportional to the state. The state is represented as modal amplitudes and velocities as determined by the sensors. The four higher frequency modes are truncated to signify a simplifying order reduction step. The feedback gains are established via steady state optimal regulator theory. System response is examined in light of the effects of observation spillover and control spillover onto a specified number of suppressed modes. M.G.

N81-27115*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
A DIGITAL PROGRAM FOR CALCULATING THE INTERACTION BETWEEN FLEXIBLE STRUCTURES, UNSTEADY AERODYNAMICS AND ACTIVE CONTROLS
E. L. PEELE and W. M. ADAMS, JR. Jan. 1979 57 p refs
(NASA-TM-80040) Avail: NTIS HC A04/MF A01 CSCL 01C

A computer program, ISAC, is described which calculates the stability and response of a flexible airplane equipped with active controls. The equations of motion relative to a fixed inertial coordinate system are formulated in terms of the airplane's rigid body motion and its unrestrained normal vibration modes. Unsteady aerodynamic forces are derived from a doublet lattice lifting surface theory. The theoretical basis for the program is briefly explained together with a description of input data and output results. Author

N81-27185# Centre d'Etudes et de Recherches en Technologie Spatiale, Toulouse (France). Dept. Automatique.
PRELIMINARY STUDY OF DIGITAL ATTITUDE CONTROL DESIGN TECHNIQUES FOR SATELLITES
J. P. CHRETIEN, P. RODRIGO, M. GAUVRIT, D. BONTOUX, and J. JODEAU Paris ESA Apr. 1979 265 p refs
(Contract ESTEC-3372/77-NL-AK(SC))
(CERT-1/7171-DERA; ESA-CR(P)-1406) Avail: NTIS HC A12/MF A01

A frequency adaptive control technique is verified, i.e., a conservative double integrator coupled to one resonant mode. Reference loops with continuous control networks are described. Methods for deriving a digital controller, using information derived from existing analog control systems, are also described. Author (ESA)

N81-28131# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
STABILITY ANALYSIS OF GRAVITY GRADIENT STABILIZED SATELLITE CONTAINING A FLEXIBLE BEAM
S. A. TAVARES and P. T. D. LOURENCAO May 1981 12 p refs Proposed for presentation at the 6th Congr. Brasileiro de Eng. Mecan., Rio de Janeiro, 15-18 Dec. 1981
(INPE-2078-RPE/313) Avail: NTIS HC A02/MF A01

The dynamic stability study of a gravity oriented flexible satellite is presented. The Lagrangian formulation for obtaining the equations of motion and the direct Liapunov method for the determination of sufficient stability conditions were used. Rayleigh quotient properties for evaluating the elastic potential energy and Schewartz inequality for obtaining the integral coordinates were used for simplifying the solution of the problem. Stability diagrams are plotted and analyzed. Author

N81-29460*# Virginia Polytechnic Inst. and State Univ., Blacksburg.
THE REDUCED ORDER MODEL PROBLEM IN DISTRIBUTED PARAMETER SYSTEMS ADAPTIVE IDENTIFICATION AND CONTROL Final Report
C. R. JOHNSON, JR. and D. LAWRENCE Aug. 1981 33 p refs
(Contract NAG1-7)
(NASA-CR-164670) Avail: NTIS HC A03/MF A01 CSCL 20K

The basic assumption that a large space structure can be decoupled preceding the application of reduced order active control was considered and alternative solutions to the control of such structures (in contrast to the strict modal control) were investigated. The transfer function matrix from the actuators to the sensors was deemed to be a reasonable candidate. More refined models from multivariable systems theory were studied and recent results in the multivariable control field were compared with respect to theoretical deficiencies and likely problems in application to large space structures. A.R.H.

N81-31528*# Raytheon Co., Sudbury, Mass. Equipment Div.
HIGH RESOLUTION ANGULAR SENSOR Final Report
M. I. GNESES and D. S. BERG Jun. 1981 108 p refs
(Contract NAS8-31840)
(NASA-CR-161843; ER81-4177) Avail: NTIS HC A06/MF A01 CSCL 14B

Specifications for the pointing stabilization system of the large space telescope were used in an investigation of the feasibility of reducing ring laser gyro output quantization to the sub-arc-second level by the use of phase locked loops and associated electronics. Systems analysis procedures are discussed and a multioscillator laser gyro model is presented along with data on the oscillator noise. It is shown that a second order closed loop can meet the measurement noise requirements when the loop gain and time constant of the loop filter are appropriately chosen. The preliminary electrical design is discussed from the standpoint of circuit tradeoff considerations. Analog, digital, and hybrid designs are given and their applicability to the high resolution sensor is examined. the electrical design choice of a system configuration is detailed. The design and operation of the various modules is considered and system block diagrams are included. Phase 1 and 2 test results using the multioscillator laser gyro are included. A.R.H.

N81-31911*# Houston Univ., Tex. Dept. of Electrical Engineerng.
RESEARCH ON NUMERICAL ALGORITHMS FOR LARGE SPACE STRUCTURES Final Report, 15 Mar. 1980 - 14 Mar. 1981
E. D. DENMAN 14 Mar. 1981 95 p refs
(Contract NSG-1603)
(NASA-CR-164721) Avail: NTIS HC A05/MF A01 CSCL 12A

Numerical algorithms for analysis and design of large space structures are investigated. The sign algorithm and its application to decoupling of differential equations are presented. The generalized sign algorithm is given and its application to several problems discussed. The Laplace transforms of matrix functions and the diagonalization procedure for a finite element equation are discussed. The diagonalization of matrix polynomials is considered. The quadrature method and Laplace transforms is discussed and the identification of linear systems by the quadrature method investigated. J.D.H.

N81-32143*# Lockheed Engineering and Management Services Co., Inc., Houston, Tex.
SOFTWARE SURVEY FOR THE AVIONICS TEST BED Interim Report
J. M. COBB Jul. 1981 113 p
(Contract NAS9-15800)
(NASA-CR-161089; JSC-17490; LEMSCO-16941) Avail: NTIS HC A06/MF A01 CSCL 01D

A survey was conducted to itemize software programs that could possibly be used in the development of an avionics test bed for shuttle attached or autonomous large space structures. The results of this survey are presented. Each program is described on a standard form. J.M.S.

N81-32168*# Howard Univ., Washington, D. C. Dept. of Mechanical Engineering.
THE DYNAMICS AND CONTROL OF LARGE FLEXIBLE SPACE STRUCTURES-IV
P. M. BAINUM, V. K. KUMAR, R. KRISHNA, and A. S. S. R. REDDY Aug. 1981 105 p refs
(Contract NSG-1414)
(NASA-CR-165815) Avail: NTIS HC A06/MF A01 CSCL 22B

The effects of solar radiation pressure as the main environmental disturbance torque were incorporated into the model of the rigid orbiting shallow shell and computer simulation results indicate that within the linear range the rigid modal amplitudes are excited in proporation to the area to mass ratio. The effect of higher order terms in the gravity-gradient torque expressions previously neglected was evaluated and found to be negligible for the size structures under consideration. A graph theory approach was employed for calculating the eigenvalues of a large flexible system by reducing the system (stiffness) matrix to lower ordered submatrices. The related reachability matrix and term rank concepts are used to verify controllability and can be more effective than the alternate numerical rank tests. Control laws were developed for the shape and orientation control of the orbiting flexible shallow shell and numerical results presented. E.D.K.

N81-33450*# Massachusetts Inst. of Tech., Cambridge. Space Systems Lab.
DYNAMIC PROFILE OF A PROTOTYPE PIVOTED PROOF-MASS ACTUATOR
D. W. MILLER Aug. 1981 29 p refs
(Contract NAG1-126)
(NASA-CR-164861; SSL-29-81) Avail: NTIS HC A03/MF A01 CSCL 14B

A prototype of a linear inertial reaction actuation (damper) device employing a flexure-pivoted reaction (proof) mass is discussed. The mass is driven by an electromechanic motor using a dc electromagnetic field and an ac electromagnetic drive. During the damping process, the actuator dissipates structural kinetic energy as heat through electromagnetic damping. A model of the inertial, stiffness and damping properties is presented along with the characteristic differential equations describing the coupled response of the actuator and structure. The equations, employing the dynamic coefficients, are oriented in the form of a feedback control network in which distributed sensors are used to dictate actuator response leading to a specified amount of structural excitation or damping. A.R.H.

N81-33451*# Massachusetts Inst. of Tech., Cambridge. Space Systems Lab.
A DEMONSTRATION OF THE USE OF GENERALIZED PARITY RELATIONS FOR DETECTION AND IDENTIFICATION OF INSTRUMENT FAILURES OF A FREE-FREE BEAM
C. S. MAJOR Sep. 1981 81 p refs
(Contract NAG1-126)
(NASA-CR-164873; SSL-28-81) Avail: NTIS HC A05/MF A01 CSCL 14B

A means of detecting failures in sensors and actuators on board large, flexible space structures is described. A failure detection and indentification (FDI) method which does not require triplication of position, attitude, and shape data is that of generalized parity relations. Parity relations are derived and an FDI routine is implemented on a computer-simulated flexible beam modeled on an experimental beam at NASA Langley Research Center. The effectiveness of the FDI procedure is relatively insensitive to disturbances and noise, but is very sensitive to modeling errors, including frequency errors, mode shape errors, and sensing and actuation spillover. J.D.H.

05

ELECTRONICS

Includes techniques for power and data distribution, antenna RF performance analysis, and communications systems.

A81-37020
NET ENERGY ANALYSIS OF SPACE POWER SATELLITES
C. C. FRANTZ and A. B. CAMBEL (George Washington University, Washington, D.C.) Energy (UK), vol. 6, June 1981, p. 485-501. refs
(Contract EG-77-G-01-4040)

A net energy analysis (NEA) of the Solar Power Satellite System is performed. Two options are compared using either silicon (Si) or gallium-aluminum-arsenide (Ga-Al-As) photovoltaic cells. The analysis is based on the DOE/NASA reference system. Maintenance and material energy costs are considered and are shown to be valid. Results show a net energy ratio (electrical output vs primary thermal input) of the order of 2-5 for the silicon cell option and 14-18 for the gallium-aluminum-arsenide option. (Author)

A81-41802* Jet Propulsion Lab., California Inst. of Tech., Pasadena.
NEUTRALIZING CHARGED-UP SPACECRAFT
H. B. GARRETT (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) IEEE Spectrum, vol. 18, July 1981, p. 44-47.

The problem of spacecraft charging is examined. The mechanism by which a spacecraft acquires a charge with respect to the ambient space environment is discussed. Methods used to avoid spacecraft dysfunction due to charging, including the use of electron and ion emitters, adequately conducting surfaces, and dielectric materials with high secondary-emission coefficients, are described. Special attention is given to the development, in the context of the Scatha program, of a computerized model which will allow the calculation of spacecraft potential for a given set of conditions. C.K.D.

A81-42533#

SOME ASPECTS OF THE CHOICE AND DESIGN OF ANTENNA SYSTEMS FOR SATELLITE SOLAR POWER STATIONS [NEKOTORYE ASPEKTY VYBORA I POSTROENIIA ANTENNYKH SISTEM SOLNECHNYKH KOSMICHESKIKH ELEKTROSTANTSII]

N. A. ARMAND, A. N. LOMAKIN, and B. M. PARAMONOV Radiotekhnika i Elektronika, vol. 26, July 1981, p. 1479-1487. In Russian. refs

Various aspects of the design of microwave power transmitting and receiving antennas in satellite solar power systems are discussed. Particular consideration is given to problems of receiving-antenna design in Eastern European countries, where safety norms specify lower levels of microwave intensity than in the United States. Attention is also given to problems of sidelobe reduction in phased arrays consisting of a chain of a large number of nonlinear amplifiers series-connected by waveguides with slot radiators. Conditions for the damping of amplitude-modulated and phase-modulated oscillations in the chain are established, and the value of the suppression coefficient is determined. B.J.

A81-44705* Old Dominion Univ., Norfolk, Va.

TECHNIQUES FOR PREDICTION OF LARGE NONANALYTIC REFLECTOR ANTENNA PERFORMANCE

S. M. MOSKOWITZ (Old Dominion University, Norfolk, VA) and M. C. BAILEY (NASA, Langley Research Center, Hampton, VA) In: SOUTHEASTCON '81; Proceedings of the Region 3 Conference and Exhibit, Huntsville, AL, April 5-8, 1981. Piscataway, NJ, Institute of Electrical and Electronics Engineers, Inc., 1981, p. 345-349. refs

(Contract NAG1-63)

Projected spacecraft missions for communications, radio astronomy and earth observations indicate a need for very large (on the order of 100 meters) space deployable or erectable antennas. This paper discusses a numerical method of analyzing reflector characteristics which is applicable to large reflector antennas whose surfaces are subject to mechanical and thermal distortions as well as fabrication and deployment errors. A technique of describing nonanalytic surface configurations by a finite number of known (measured) points was successfully applied in a computer model to predict the RF radiation pattern of a reflector using aperture plane integration techniques. The accuracy of the results is shown to be both a function of the number of measured points used and of their distribution. (Author)

A81-45296

SURFACE-CURRENT ANALYSIS OF DISTORTED REFLECTOR ANTENNAS

K. K. CHAN and A. R. RAAB (SPAR Aerospace, Ltd., Sainte-Anne-de Bellevue, Quebec, Canada) IEE Proceedings, Part H - Microwaves, Optics and Antennas, vol. 128, pt. H, no. 4, Aug. 1981, p. 206-212. refs

An important requirement in satellite antenna design is the prediction of the antenna performance when it is placed in the space orbital environment. An accurate estimate of its performance deterioration, caused by antenna distortions which are induced by the temperature extremes encountered, should be obtained. A method suitable for this type of analysis of reflector antennas is presented. It involves the division of the reflector surface into triangular elements whose distortions are computed using a structural analysis program (NASTRAN). The currents flowing on each distorted elemental surface are then used to give the diffracted fields. The computed results of an offset fed reflector are given. A way is suggested, which makes use of monopulse tracking, to minimize the performance degradation caused by the surface distortion. (Author)

A81-47326

ADVANCED HIGH CAPACITY DOMESTIC SATELLITE COMMUNICATIONS SYSTEM

A. ISO, K. KOHIYAMA, H. ODATE, and N. ISHIDA (Nippon Telegraph and Telephone Public Corp., Yokosuka Electrical Communication Laboratory, Yokosuka, Kanagawa, Japan) International Astronautical Federation, International Astronautical Congress, 32nd, Rome, Italy, Sept. 6-12, 1981, 12 p. refs

(IAF PAPER 81-65)

The high capacity transmission of a 30/20 GHz and 50/40 GHz domestic satellite communication system is presented with an investigation of the relationship between satellite antenna pointing accuracy, multibeam antenna interference, and multisatellite interference. Antenna pointing is found to affect an antenna's gain and pattern and multibeam interference; thus the antenna beam width is defined to include antenna pointing accuracy. Results include a 6 m antenna gain of 69.5 dB at 20 GHz for 114 beams with a pointing accuracy of 0.05 deg, and a 17.6 m gain of 69.0 dB at 20 GHz for 630 beams with an accuracy of 0.01 deg. The frequency reuse number is given as a function of total beam number and pointing accuracy, and a bandwidth of 7 GHz allocated at 30/20 and 50/40 GHz is made possible by multispot beam antennas and linearly polarized waves. D.L.G.

A81-47395

SPACE NUCLEAR REACTORS - ENERGY GATEWAY INTO THE NEXT MILLENNIUM

J. A. ANGELO, JR. (U.S. Defense Nuclear Agency, Los Alamos, NM) and D. BUDEN (California, University, Los Alamos, NM) International Astronautical Federation, International Astronautical Congress, 32nd, Rome, Italy, Sept. 6-12, 1981, 22 p. Research sponsored by the U.S. Department of Energy. refs

(IAF PAPER 81-183)

In anticipation of future needs for the propulsion of large quantities of materials through both lunar and translunar space, and the powering of sophisticated satellites, space platforms and space stations, components are being developed for a compact, 100-kWe heat pipe nuclear reactor. The objectives of this program are: (1) the development of space-based nuclear powerplant components capable of unattended operation for seven to nine years; (2) component reliability factors of more than 0.95; (3) reactor weight lower than 1910 kg; and (4) compatibility with Space Shuttle Orbiter development. Schemes are presented for the application of such nuclear powerplants to large, integrated orbital facilities, lunar bases and interplanetary transportation systems. O.C.

N81-22069*# McDonnell-Douglas Astronautics Co., Huntington Beach, Calif. Radar and RF Subsystems.

SCIENCE AND APPLICATIONS SPACE PLATFORM (SASP) END-TO-END DATA SYSTEM STUDY Final Report

P. R. CRAWFORD and L. H. KASULKA Apr. 1981 80 p refs

(Contract NAS8-33592)

(NASA-CR-161753; MDC-G9372) Avail: NTIS HC A05/MF A01 CSCL 22B

The capability of present technology and the Tracking and Data Relay Satellite System (TDRSS) to accommodate Science and Applications Space Platforms (SASP) payload user's requirements, maximum service to the user through optimization of the SASP Onboard Command and Data Management System, and the ability and availability of new technology to accommodate the evolution of SASP payloads were assessed. Key technology items identified to accommodate payloads on a SASP were onboard storage devices, multiplexers, and onboard data processors. The primary driver is the limited access to TDRSS for single access channels due to sharing with all the low Earth orbit spacecraft plus shuttle. Advantages of onboard data processing include long term storage of processed data until TRDSS is accessible, thus reducing the loss of data, eliminating large data processing tasks at the ground stations, and providing a more timely access to the data. J.M.S.

N81-22861# Los Alamos Scientific Lab., N. Mex.
SPACE NUCLEAR POWER: A STRATEGY FOR TOMORROW
D. BUDEN and J. A. ANGELO, JR. 1981 12 p refs Presented at Am. Inst. of Aeron. and Astron. Conf. on Large Space Platforms, San Diego, Calif., 2 Feb. 1981
(Contract W-7405-ENG-36)
(LA-UR-80-3592; CONF-810205-1) Avail: NTIS HC A02/MF A01

Space-based nuclear power, in turn, is a key technology for developing space platforms and the transportation systems necessary to service them. A strategy for meeting space power requirements is discussed. The development of a 100 kW(e) nuclear reactor system for high Earth orbit missions, transportation from shuttle orbits to geosynchronous orbit, and for outer planet exploration is described. It is concluded that as permanent settlements are established on the Moon and in space, multimegawatt power plants will be needed. This involves different technology which is similar to terrestrial nuclear power plants.
DOE

N81-25508*# Honeywell Systems and Research Center, Minneapolis, Minn.
SPECTROPHOTOVOLTAIC ORBITAL POWER GENERATION Progress Report
G. KNOWLES, D. STOLTZMAN, R. LIN, and S. K. LO 18 Dec. 1980 59 p
(Contract NAS8-33511)
(NASA-CR-161795) Avail: NTIS HC A04/MF A01 CSCL 10A

A system with 1000 : 1 concentration ratio is defined, using a cassegrain telescope as the first stage concentration (270 x) and compound parabolic concentrators (CPC) for the second stage concentration of 4.7 x for each spectral band. Using reported state of the art (S.O.A.) solar cells device parameters and considering structural losses due to optics and beamsplitters, the efficiencies of one to four cell systems were calculated with efficiencies varying from approximately 22% to 30%. Taking into account cost of the optics, beamsplitter, radiator, and the cost of developing new cells the most cost effective system is the GaAs/Si system.
T.M.

N81-33612*# LinCom Corp., Pasadena, Calif.
SOLAR POWER SATELLITE ANTENNA PHASE CONTROL SYSTEM HARDWARE SIMULATION, PHASE 4: VOLUME 1: EXECUTIVE SUMMARY Final Report
W. C. LINDSEY, A. V. KANTAK, and C. M. CHIE Mar. 1981 22 p refs 3 Vol.
(Contract NAS9-16097)
(NASA-CR-167393; TR-0381-1280-VOL-1) Avail: NTIS HC A02/MF A01 CSCL 10A

The phase control system is described. Potential sources of phase error are identified and the performance leading to selection of the allowable phase error for each source is summarized. The pilot transmitter, the effects of ionospheric, the master slave returnable timing system (MSRTS), the SPS receiver, and the high power amplifier for dc to microwave conversion are considered separately. Design parameters of the pilot transmitter and spacetenna transponder are presented.
J.D.H.

N81-33613*# LinCom Corp., Pasadena, Calif.
SOLAR POWER SATELLITE ANTENNA PHASE CONTROL SYSTEM HARDWARE SIMULATION, PHASE 4. VOLUME 2: ANALYTICAL SIMULATION OF SPS SYSTEM PERFORMANCE Final Report
W. C. LINDSEY, A. V. KANTAK, and C. M. CHIE Mar. 1981 93 p refs 3 Vol.
(Contract NAS9-16097)
(NASA-CR-167394; TR-0381-1280-VOL-2) Avail: NTIS HC A05/MF A01 CSCL 10A

The pilot signal parameter optimization and power transponder analyses are presented. The SPS antenna phase control system is modeled and the hardware simulation study described. Ionospheric and system phase error effects and the effects of high power amplifier phase and amplitude jitters are considered. Parameter optimization of the spread spectrum receiver, consisting of the carrier tracking loop and the code tracking loop, is described.
J.D.H.

N81-33614*# LinCom Corp., Pasadena, Calif.
SOLAR POWER SATELLITE ANTENNA PHASE CONTROL SYSTEM HARDWARE SIMULATION, PHASE 4. VOLUME 3: SOLARSIM USERS MANUAL Final Report
W. C. LINDSEY, A. V. KANTAK, and C. M. CHIE Mar. 1981 41 p refs 3 Vol.
(Contract NAS9-16097)
(NASA-CR-167395; TR-0381-1280-VOL-3) Avail: NTIS HC A03/MF A01 CSCL 10A

Documentation of the interactive software package designed to predict the effect of certain electrical and mechanical imperfections on the performance of the SPS system is presented. The capabilities of the SOLARSIM program to quantify the spacetenna performance parameter values are described. The SOLARSIM package can compute the RMS pointing error, title effects, MPTX code tracking loop performance, MPTX carrier tracking loop performance, averaged power pattern, and the power transfer efficiency.
J.D.H.

06

ADVANCED MATERIALS

Includes matrix composites, polyimide films, thermal control coatings, bonding agents, antenna components, manufacturing techniques, and space environmental effects on materials.

A81-32919#
ADVANCED COMPOSITES - A REVOLUTION FOR THE DESIGNER
C. ZWEBEN (General Electric Co., Space Div., King of Prussia, Pa.) American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display on Frontiers of Achievement, Long Beach, Calif., May 12-14, 1981, 22 p. refs
(AIAA PAPER 81-0894)

The progress made in materials composition, fabrication methods and aerospace applications design over the last 20 years in the field of composite materials is discussed, with stress on aircraft, missile, spacecraft and Space Shuttle Orbiter components. Among the issues discussed are military, high-performance and civil aircraft uses of advanced composites, and such possible future developments as Kevlar and alumina fiber reinforcements, silicon carbide whiskers, magnesium and titanium metal matrices, and ceramic matrix/ceramic fiber composites for high-temperature applications.
O.C.

A81-39163#
SOLAR ABSORPTANCE DEGRADATION OF OSR RADIATORS ON THE COMSTAR SATELLITES
N. L. HYMAN (COMSAT Laboratories, Clarksburg, MD) American Institute of Aeronautics and Astronautics, Thermophysics Conference, 16th, Palo Alto, CA, June 23-25, 1981, 9 p. Research sponsored by the Communications Satellite Corp. refs
(AIAA PAPER 81-1185)

The constant power dissipation, well-defined solar exposure, and reliable temperature telemetry of the Comstar satellite beacon experiments have permitted accurate derivation of increase in solar absorptance of their OSR radiators. Each of three satellites has provided more than 5,500 ESH (2 years) of data from synchronous orbit. Methods of data collection, reduction, and interpretation are presented. An increase in solar absorptance at solar incidence angles greater than 15 deg off-normal was discovered. Rates of increase in solar absorptance were constant during the last 3,000 ESH, varying from 0.0048 to 0.0085 per 1,000 ESH (0.012 to 0.021 per year) among radiators. The larger degradation rate of the most recently launched radiators may be due to inadequate cleaning of deposits from a 2-year storage. (Author)

A81-43626* Rockwell International Science Center, Thousand Oaks, Calif.

CHEMICAL ANALYSIS OF LARC-160 POLYIMIDE

P. J. DYNES (Rockwell International Science Center, Thousand Oaks, CA) In: Materials 1980; Proceedings of the Twelfth National Technical Conference, Seattle, WA, October 7-9, 1980. Azusa, CA, Society for the Advancement of Material and Process Engineering, 1980, p. 402-413. refs
(Contract NAS1-15371)

As part of a detailed NASA-sponsored study of chemical composition/property sensitivity of the LARC-160 polymerization of monomeric reactants (PMR) polyimide system, a number of liquid chromatographic techniques have been employed. The ester monomers in this system are characterized by a reverse-phase ion-suppression method. Mono, di, and triesters of the 3,3',4,4'-benzophenonetetracarboxylic acid ingredient are identified and their isomeric forms resolved. The 5-norbornene-2,3-dicarboxylic acid ester (nadic ester) endcapper is detected by low wavelength ultraviolet sensing. A second method, reverse-phase ion-pair chromatography, is employed for determining unreacted amines. The extent of resin B-staging is monitored through analysis of the ester/amine oligomers. (Author)

A81-43664

ADVANCED COMPOSITE DESIGN DATA FOR SPACECRAFT STRUCTURAL APPLICATIONS

J. F. HASKINS (General Dynamics Corp., Convair Div., San Diego, CA) In: Materials 1980; Proceedings of the Twelfth National Technical Conference, Seattle, WA, October 7-9, 1980. Azusa, CA, Society for the Advancement of Material and Process Engineering, 1980, p. 977-988.
(Contract F33615-77-C-5279)

An experimental study has been carried out to investigate the long-term effects of space environment on the mechanical properties and thermal expansion of two graphite/epoxy materials: T300/934, a high-strength system with a 350 F capability, and GY70/X30, an ultra-high-modulus system used for high-stiffness and thermally stable applications. The effects of space environment were simulated by exposing the materials to three levels of uniform radiation. Changes in mechanical properties due to radiation were small, except at high temperatures. Since radiation clearly lowered the glass transition temperature below the upper test temperature, both tensile and shear strengths were lowered at the elevated temperatures. There was also some indication that the lower radiation levels may even improve the mechanical properties, which however needs further investigation. V.L.

A81-44336* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

A MULTI-PURPOSE THERMOPLASTIC POLYIMIDE

A. K. SAINT CLAIR and T. L. SAINT CLAIR (NASA, Langley Research Center, Hampton, VA) In: Material and process applications - Land, sea, air, space; Proceedings of the Twenty-sixth National Symposium and Exhibition, Los Angeles, CA, April 28-30, 1981. Azusa, CA, Society for the Advancement of Material and Process Engineering, 1981, p. 165-178. refs

A linear thermoplastic polyimide, LARC-TPI, has been characterized and developed for a variety of high-temperature applications. In its fully imidized form, this new material can be used as an adhesive for bonding metals such as titanium, aluminum, copper, brass, and stainless steel. LARC-TPI is being evaluated as a thermoplastic for bonding large pieces of polyimide film to produce flexible, 100% void-free laminates for flexible circuit applications. The further development of LARC-TPI as a potential molding powder, composite matrix resin, high-temperature film and fiber will also be discussed. (Author)

A81-44343

ADVANCED COMPOSITES APPLICATIONS IN RCA SATELLITES

R. N. GOUNDER (RCA, Astro Electronics Div., Princeton, NJ) In: Material and process applications - Land, sea, air, space; Proceedings of the Twenty-sixth National Sy[illegible]ium and Exhibition, Los Angeles, CA, April 28-30, 1981. Azus[illegible]A, Society for the Advancement of Material and Process Engineering, 1981, p. 216-231.

Advanced lightweight materials systems with superb specific strength and special stiffness characteristics are required to meet property specifications for a use in satellite system structures and weight constraints imposed by the launch vehicle. A brief review is provided of selected applications of advanced composite materials to specific satellite hardware. In a comparison of the stiffness and strength properties of the various types of advanced reinforcement fibers with the conventional materials it can be seen that these properties in the case of the advanced fibers are much superior to those of the conventional materials. The advanced fibers are, therefore, employed to reinforce conventional materials, such as organics and metals. Attention is given to the use of advanced composites in lightweight polarized antenna reflector designs, in waveguides, feed horns, in precision mounting platforms, and in satellite structural subsystems. G.R.

A81-44353* Lockheed Missiles and Space Co., Sunnyvale, Calif.

THE CHALLENGES OF MANUFACTURING GRAPHITE-EPOXY STRUCTURAL COLUMNS FOR SPACE PLATFORMS

R. L. VAUGHN and C. A. FRIEND (Lockheed Missiles and Space Co., Inc., Space Systems Div., Sunnyvale, CA) In: Material and process applications - Land, sea, air, space; Proceedings of the Twenty-sixth National Symposium and Exhibition, Los Angeles, CA, April 28-30, 1981. Azusa, CA, Society for the Advancement of Material and Process Engineering, 1981, p. 339-349. NASA-supported research.

A description is given of the manufacturing processes developed for large-quantity production of space structure graphite/epoxy composite tubes. The tubes are to be delivered to orbit by the Space Shuttle and assembled by astronaut-assisted assembly machines. The tooling and manufacturing system uses a novel method of dry fiber placement which carefully controls fiber position and orientation and a non-autoclave cure for the epoxy resin. The means of dimensional tolerance control over differential thermal expansion between metal tooling and graphite tubes, resin shrinkage during cure, hot pressurized resins in close tolerance tooling, and tool wear, are examined in detail. A successful pilot production program is also reported. O.C.

A81-44354

DIMENSIONALLY STABLE MESH FOR SPACECRAFT LARGE ANTENNAS

D. J. LEVY, C. R. ARNOLD (Lockheed Research Laboratories, Palo Alto, CA), D. H. MA, and W. D. WADE (Lockheed Missiles and Space Co., Inc., Sunnyvale, CA) In: Material and process applications - Land, sea, air, space; Proceedings of the Twenty-sixth National Symposium and Exhibition, Los Angeles, CA, April 28-30, 1981. Azusa, CA, Society for the Advancement of Material and Process Engineering, 1981, p. 350-361. Research supported by the Lockheed Independent Research Program.

The development of an ultra-low expansion antenna mesh, for use in highly accurate space erectable antenna reflectors, is presented. Two methods of preparing such a mesh are considered: in one method, a negative-coefficient of thermal expansion (CTE) substrate yarn is coated with a suitable thickness of positive CTE metal, and in the other, a thin coating of RF-reflective metal is bonded to a substrate yarn with very low CTE. A mesh with a CTE of 0.4 x 10 to the -6th/deg C is developed by the coating technique. It is composed of metallized, woven, continuous-filament quartz, and it exhibits excellent metal adherence and electrical resistivity, and good strength and durability. K.S.

A81-47617#

ANALYSIS AND SYNTHESIS OF HIGH-PRECISION SPACE STRUCTURES OF CARBON FIBER PLASTIC

H. J. BAIER and M. W. SCHNEERMANN (Dornier System GmbH, Friedrichshafen, West Germany) Deutsche Gesellschaft fuer Luft- und Raumfahrt, Jahrestagung, Aachen, West Germany, May 11-14, 1981, 16 p. Bundesministerium fuer Forschung und Technologie refs
(Contract BMFT-01-TB-48-A-ZK/RT/WRT)
(DGLR PAPER 81-053)

Carbon-fiber-reinforced plastics are used to meet the high dimensional stability requirements of high-precision space structures. The stability properties (thermal, moisture, temporal, and stress) are shown to have a cross-interdependence on the material parameters (basic, surface, defect, structural, and joints). Three typical space structures are presented, whose development and design are analytically predicted, based on their material and structural parameters: the faint object camera, the satellite antenna reflector shell, and the communication platform. A static structural and component analysis under thermal, moisture, and radiation loads is conducted first. The micromechanics of a laminate analysis are then given; the interaction of this analysis with the finite element analysis is shown in a block diagram. Viscoelastic and creep effects are considered and a dynamic and a fatigue analysis is presented. Finally, the mathematical optimization of the total structure is formulated, as is a means for minimizing the ideal contour deviations. J.F.

N81-27281*# George Washington Univ., Washington, D.C.

LOW-ENERGY ELECTRON EFFECTS ON TENSILE MODULUS AND INFRARED TRANSMISSION PROPERTIES OF A POLYPYROMELLITIMIDE FILM

J. E. FERL (Joint Inst. for Advancement of Flight Sciences, Hampton, Va.) and E. R. LONG, JR. Jun. 1981 18 p refs
(NASA-TM-81977; L-13935) Avail: NTIS HC A02/MF A01
CSCL 07D

Infrared (IR) spectroscopy and tensile modulus testing were used to evaluate the importance of experimental procedure on changes in properties of pyromellitic dianhydride-p,p prime-oxydianiline film exposed to electron radiation. The radiation exposures were accelerated, approximate equivalents to the total dose expected for a 30 year mission in geosynchronous Earth orbit. The change in the tensile modulus depends more on the dose rate and the time interval between exposure and testing then on total dose. The IR data vary with both total dose and dose rate. A threshold dose rate exists below which reversible radiation effects on the IR spectra occur. Above the threshold dose rate, irreversible effects occur with the appearance of a new band. Post-irradiation and in situ IR absorption bands are significantly different. It is suggested that the electron radiation induced metastable, excites molecular states. E.A.K.

N81-30200# Messerschmitt-Boelkow-Blohm G.m.b.H., Ottobrunn (West Germany). Unternehmensbereich Drehfluegler.

LOW TEMPERATURE PROPERTIES OF CARBON FIBER REINFORCED EPOXIES

W. WEISS 1 Aug. 1980 28 p refs Presented at Intern. Cryogenic Mater. Conf. on Nonmetal. Mater. and Composites at Low Temp., Geneva, 4-5 Aug. 1980
(MBB-UD-310/80-OE) Avail: NTIS HC A03/MF A01

The mechanical and thermal properties of carbon fiber reinforced composites were investigated. The values obtained are given. The development of test procedures, test specimens, and test equipment is described. The experimentally measured parameters are used to design highly loaded composite structures. The static and dynamic behavior of a typical load introduction element is presented for several configurations with different fibers. The materials tested exhibited good static and dynamic load resistance. Tests on glass, carbon, and aramid composites indicated a remarkable increase in fatigue life at low temperatures. Author (ESA)

07

ASSEMBLY CONCEPTS

Includes automated manipulator techniques, EVA, robot assembly, teleoperators, and equipment installation.

A81-31390* Jet Propulsion Lab., California Inst. of Tech., Pasadena.

ROLE OF TELEOPERATORS IN SPACE STRUCTURES TECHNOLOGY

A. K. BEJCZY (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.) Society of Allied Weight Engineers, Annual Conference, 39th, St. Louis, Mo., May 12-14, 1980, 14 p. refs
(Contract NAS7-100)
(SAWE PAPER 1370)

A review is presented of extensive experimental work on the control of remote manipulators for handling, assembly, and maintenance work on large orbiting structures. Among the prime areas identified for further research and development are: new sensor system concepts to make sensors suitable for the highly demanding space environment, improved man/machine interface designs to provide a more efficient command/information flow between operator and remote manipulator, and new approaches to the design of interactive manual/computer controls within the framework of a supervisory control system. O.C.

A81-41198#

FUTURE APPLICATIONS OF REMOTE MANIPULATORS IN SPACE

C. G. WAGNER-BARTAK (Spar Aerospace, Ltd., Remote Manipulator Systems Div., Toronto, Canada) (Canadian Aeronautics and Space Institute, Canadian Conference on Astronautics, 1st, Ottawa, Canada, Oct. 20-22, 1980.) Canadian Aeronautics and Space Journal, vol. 27, 1st Quarter, 1981, p. 17-25.

The Shuttle Remote Manipulator System (RMS) will help to bring the Space Transportation System to full routine operational status by the early 1980's. The RMS comprises three major elements, including a 50 ft long manipulator arm attached to the port longeron of the Shuttle Orbiter cargo bay, a display and control system, and a payload interface. The arm is operated by the use of hand controllers and a dedicated RMS display and control panel located in the Orbiter crew compartment. Current RMS applications are discussed, taking into account a power extension package, Spacelab, the multi-mission modular spacecraft, and a manned remote work station. Attention is also given to future space manipulator tasks, future space manipulators, and robotic manipulators. G.R.

A81-43723* National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

COMPUTER CONTROL OF A ROBOTIC SATELLITE SERVICER

K. R. FERNANDEZ (NASA, Marshall Space Flight Center, Huntsville, AL; Vanderbilt University, Nashville, TN) In: SOUTHEASTCON '80; Proceedings of the Region 3 Conference and Exhibit, Nashville, TN, April 13-16, 1980. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 237-240.

The advantages that will accrue from the in-orbit servicing of satellites are listed. It is noted that in a concept in satellite servicing which holds promise as a compromise between the high flexibility and adaptability of manned vehicles and the lower cost of an unmanned vehicle involves an unmanned servicer carrying a remotely supervised robotic manipulator arm. Because of deficiencies in sensor technology, robot servicing would require that satellites be designed according to a modular concept. A description is given of the servicer simulation hardware, the computer and interface hardware, and the software. It is noted that several areas require further development; these include automated docking, modularization of satellite design, reliable connector and latching mechanisms, development of manipulators for space environments, and development of automated diagnostic techniques. C.R.

A81-44629
SPACE MANUFACTURING STUDIES FOR SPS
D. B. S. SMITH (MIT, Cambridge, MA) In: Space - Enhancing technological leadership; Proceedings of the Twenty-seventh Annual Meeting, Boston, MA, October 20-23, 1980. San Diego, CA, American Astronautical Society; Univelt, Inc., 1981, p. 229-246. refs
(AAS 80-223)

Two aspects of the production of Solar Power Satellites (SPS), i.e., manufacture of components, and assembly in space of large structures for an SPS, are reviewed. A solar cell factory design is presented by describing a reference in-space facility, which receives beneficiated raw materials from the moon, logistics and some raw materials from the earth, and energy from the sun; it produces components of one 10-gigawatt SPS per year. A cost summary of the reference system is also given. Research is conducted on underwater simulation of human assembly of large space structures in zero-g, and simulation of a truss-structure assembly is described. It is concluded that although automation is desirable for repetitive manufacturing operations and special situations, replacing personnel by machinery will not yield significant reductions in program costs. K.S.

A81-46463
REMOTE ARM AIDS SHUTTLE CAPABILITY
C. COVAULT Aviation Week and Space Technology, vol. 115, Sept. 7, 1981, p. 57, 59, 60, 65, 68, 73.

Operation of the remote manipulator system arm from the Space Shuttle Orbiter's aft cockpit station required the development of a highly interactive man/machine interface, which uses the same rotational and translational hand controller concepts as those of the Orbiter. Among the topics covered in this status report on the Shuttle Mission 2 remote arm experiment package are: (1) crew-training simulator procedures; (2) forward and aft camera functions; (3) problem-solving techniques employed during the arm design program; and (4) manipulator arm operation simulation modes, including automatic, manual augmented, manual single-joint drive, direct drive, and manual backup. The most useful display of the simulation system is held to be a block of three digital readouts that, depending on selection via rotary switch, can call out the X, Y and Z axis positions of the arm in inches or attitudes in pitch, yaw and roll on an angular degree scale. O.C.

A81-47302
COMPARISON OF MANNED AND AUTOMATIC TECHNIQUES FOR ORBITAL ACTIVITIES
G. PETERS (ESA, Paris, France), M. L. DO, and J. L. LACOMBE (MATRA, S.A., Velizy-Villacoublay, Yvelines, France) International Astronautical Federation, International Astronautical Congress, 32nd, Rome, Italy, Sept. 6-12, 1981, 12 p.
(IAF PAPER 81-26)

Technical problems involved in the performance of space applications missions by man and by automatic systems are compared. The relative merits of manned and automatic approaches to typical functions to be performed in future space activities, including rendezvous and docking, transfers of materials or resources, assembly and construction, and the return of space-processed materials, are discussed, and the implications of the two approaches are illustrated for two typical missions: advanced materials processing in low earth orbit and a geostationary telecommunications platform. The problem of the servicing, maintenance and repair of long-duration applications missions is then considered in relation to the two approaches. It is pointed out that whereas the maximum use of man is being planned for Shuttle-serviced orbits, excessive costs may preclude routine manned operations at geosynchrounous orbits. Implications for the future direction of European space development activities in the fields of rendezvous and docking capacities, automatic materials transfer and retrieval and telemanipulators for maintenance and service are indicated. A.L.W.

A81-47309* Martin Marietta Aerospace, Denver, Colo.
DEVELOPMENT AND APPLICATION OF THE MANNED MANEUVERING UNIT, WORK RESTRAINT SYSTEM, STOWAGE CONTAINER AND RETURN LINE TETHER
F. H. BERGONZ, J. K. OKELLY (Martin Marietta Aerospace, Denver, CO), C. W. WHITSETT, and W. W. PETYNIA (NASA, Johnson Space Center, Houston, TX) International Astronautical Federation, International Astronautical Congress, 32nd, Rome, Italy, Sept. 6-12, 1981, 19 p.
(IAF PAPER 81-39)

The Manned Maneuvering Unit (MMU), a self-contained zero-gravity backpack designed for astronaut extravehicular activity, is discussed with reference to the system requirements and characteristics, and potential near-term and future uses. Attention is given to the MMU man-machine interfaces, propulsion capability, attitude control, crew restraint hardware, donning, doffing, activation, and deactivation. Specific applications discussed include: spacecraft inspection and servicing, assembly of large space systems, payload deployment/retrieval, and crew rescue. V.L.

A81-47966
ORBITAL CONSTRUCTION
G. L. BORROWMAN Spaceflight, vol. 23, Oct. 1981, p. 238-242. refs

The importance of having a place in space where payloads could be left by the Shuttle is stressed. A description is given of the operation of a beam builder and a cherry picker. It is noted that a permanent construction facility - a Space Operations Center - would support the flight development of the construction equipment and operational techniques begun with the Shuttle. It would also implement these techniques to construct, check out, and transfer large space systems to operational orbits. C.R.

N81-24448*# Lockheed Missiles and Space Co., Sunnyvale, Calif.
LARGE PLATFORM ASSEMBLER NON-STRUCTURAL SYSTEM REQUIREMENTS Final Report
R. M. VERNON Apr. 1981 81 p refs
(Contract NAS1-15240)
(NASA-CR-165743; LMSC-D760269) Avail: NTIS HC A05/MF A01 CSCL 22B

The impact on the design and operation of an automated structure assembler of requiring the assembler to also install the platform electrical and/or fluid utility circuits was examined. Possible utility requirements were defined and examined in conjunction with the automated assembler. Preliminary concepts are presented which permit the electrical and fluid circuits to be installed with the structural elements. A.R.H.

N81-26160*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
EVA ASSEMBLY OF LARGE SPACE STRUCTURE ELEMENT
L. J. BEMENT, H. G. BUSH, W. L. HEARD, JR., and J. W. STOKES, JR. (NASA, Marshall Space Flight Center) Jun. 1981 38 p refs
(NASA-TP-1872; L-14353) Avail: NTIS HC A03/MF A01 CSCL 22A

The results of a test program to assess the potential of manned extravehicular activity (EVA) assembly of erectable space trusses are described. Seventeen tests were conducted in which six 'space-weight' columns were assembled into a regular tetrahedral cell by a team of two 'space'-suited test subjects. This cell represents the fundamental 'element' of a tetrahedral truss structure. The tests were conducted under simulated zero-gravity conditions. Both manual and simulated remote manipulator system modes were evaluated. Articulation limits of the pressure suit and zero gravity could be accommodated by work stations with foot restraints. The results of this study have confirmed that astronaut EVA assembly of large, erectable space structures is well within man's capabilities. Author

N81-26718* National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
PNEUMATIC INFLATABLE END EFFECTOR Patent
K. H. CLARK and J. D. JOHNSTON, inventors (to NASA) 16 Jun. 1981 4 p Filed 22 Sep. 1978 Supersedes N78-32724 (16 - 23, p 2133)
(NASA-CASE-MFS-23696-1; US-PATENT-4,273,505; US-PATENT-APPL-SN-945044; US-PATENT-CLASS-414-735; US-PATENT-CLASS-294-93; US-PATENT-CLASS-414-4; US-PATENT-CLASS-414-744A) Avail: US Patent and Trademark Office CSCL 13I

The invention relates to an end effector device for robot or teleoperated type space vehicle which includes an inflatable balloon member carried on the end of tubular member which has a hollow center or conduit through which a suitable pressurized fluid is supplied. The device may be inserted into a variety of shaped openings or truss-type structures for handling in space.

Official Gazette of the U.S. Patent and Trademark Office

N81-26113*# Rensselaer Polytechnic Inst., Troy, N. Y.
DATA ACQUISITION AND ANALYSIS OF RANGE-FINDING SYSTEMS FOR SPACING CONSTRUCTION Annual Report, 1 May 1980 - 30 Apr. 1981
C. N. SHEN 1981 52 p refs
(Contract NAG1-61)
(RPI-TR-MP-81; NASA-CR-164643) Avail: NTIS HC A04/MF A01 CSCL 22A

For space missions of future, completely autonomous robotic machines will be required to free astronauts from routine chores of equipment maintenance, servicing of faulty systems, etc. and to extend human capabilities in hazardous environments full of cosmic and other harmful radiations. In places of high radiation and uncontrollable ambient illuminatins, T.V. camera based vision systems cannot work effectively. However, a vision system utilizing directly measured range information with a time of flight laser rangefinder, can successfully operate under these environments. Such a system will be independent of proper illumination conditions and the interfering effects of intense radiation of all kinds will be eliminated by the tuned input of the laser instrument. Processing the range data according to certain decision, stochastic estimation and heuristic schemes, the laser based vision system will recognize known objects and thus provide sufficient information to the robot's control system which can develop strategies for various objectives. Author

08

PROPULSION

Includes propulsion concepts and designs utilizing solar sailing, solar electric, ion, and low thrust chemical concepts.

A81-40881#
PROPULSION CONCEPTS FOR LARGE SPACE SYSTEMS
L. R. REDD and W. E. PIPES (Martin Marietta Aerospace, Denver, CO) AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA 10 p.
(AIAA PAPER 81-1454)

Several propulsion candidates for Large Space Systems (LSS) orbit transfer to geostationary orbit (GEO) are considered, consisting of various combinations of chemical and electric propulsion stages employing state-of-the-art and advanced technology concepts. An optimum vehicle was chosen on the basis of life cycle cost, technological risk, safety, and environmental concerns, where requirements include high total impulse, low-thrust engines, stage compactness, and rendezvous and docking capability. Among the topics covered are: (1) the candidates considered; (2) trade studies and analyses; (3) recommendations of candidates for further development; and (4) technological requirements that must be satisfied before construction of the recommended system can begin. O.C.

A81-40933#
POTENTIAL MILITARY SPACE SYSTEMS APPLICATIONS FOR ADVANCED ELECTRIC PROPULSION SYSTEMS
R. L. CHASE (Analytic Services, Inc., Arlington, VA) AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA 9 p. refs
(AIAA PAPER 81-1536)

The military need for electric propulsion in the post-1990 time period is considered, from the perspectives of both mission capability and survivability, as a major contribution to a 'space architecture' of orbital systems related by a common objective and strategy. Two generic classes of electric propulsion, an advanced ion thruster and a magnetoplasma dynamic (MPD) thruster, are discussed, and it is recommended that the MPD thruster be given priority in research, along with low molecular weight working fluids and ultraviolet power beaming to the thruster from earth. Among the candidate applications are: (1) post-attack resupply vehicle; (2) low-thrust orbit transfer module; (3) reconnaissance and inspection vehicle; (4) satellite defense mobile platform; and (5) satellite resupply and service. O.C.

A81-42198*# Martin Marietta Aerospace, Denver, Colo.
PROPELLANT MANAGEMENT FOR LOW THRUST CHEMICAL PROPULSION SYSTEMS
K. M. HAMLYN, R. H. DERGANCE (Martin Marietta Aerospace, Denver, CO), and J. C. AYDELOTT (NASA, Lewis Research Center, Cleveland, OH) AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA 9 p. refs
(AIAA PAPER 81-1453)

Low-thrust chemical propulsion systems (LTPS) will be required for orbital transfer of large space systems (LSS). The work reported in this paper was conducted to determine the propellant requirements, preferred propellant management technique, and propulsion system sizes for the LTPS. Propellants were liquid oxygen (LO2) combined with liquid hydrogen (LH2), liquid methane or kerosene. Thrust levels of 100, 500, and 1000 lbf were combined with 1, 4, and 8 perigee burns for transfer from low earth orbit to geosynchronous earth orbit. This matrix of systems was evaluated with a multilayer insulation (MLI) or a spray-on-foam insulation. Vehicle sizing results indicate that a toroidal tank configuration is needed for the LO2/LH2 system. Multiple perigee burns and MLI allow far superior LSS payload capability. Propellant settling, combined with a single screen device, was found to be the lightest and least complex propellant management technique. (Author)

A81-42200*# Rocketdyne, Canoga Park, Calif.
LOW THRUST CHEMICAL PROPULSION FOR ORBIT TRANSFER OF LARGE SPACE STRUCTURES
J. M. SHOJI (Rockwell International Corp., Rocketdyne Div., Canoga Park, CA) AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA 22 p.
(Contract NAS3-21941)
(AIAA PAPER 81-1459)

For transporting Large Space Structures (LSS) from Low Earth Orbit (LEO) to Geosynchronous Equatorial Orbit (GEO), a variety of low thrust engine cycles have been evaluated for oxygen/hydrogen and oxygen/hydrocarbon propellants. The engine cycles included conventional propellant turbine drives (gas generator, expander, and staged-combustion cycles), turboalternator/electric motor pump drive, and fuel-cell/electric motor pump drive, as well as pressure-fed engines. The thrust chamber cooling limits and the engine cycle limits were established for a range of thrust levels. The candidate engine cycles were analyzed, screened, rated, and two engine cycle/configurations were selected for preliminary engine design. Preliminary engine designs for these two engines were formulated and engine design layouts prepared and parametric engine data generated.

(Author)

A81-47478
LIQUID BIPROPELLANT ENGINES FOR LARGE TELECOMMUNICATIONS SATELLITES
S. D. ROSENBERG (Aerojet Liquid Rocket Co., Sacramento, CA) International Astronautical Federation, International Astronautical Congress, 32nd, Rome, Italy, Sept. 6-12, 1981, 11 p.
(IAF PAPER 81-367)

The paper reviews the engine design, delivered performance, durability, and life of liquid bipropellant engines for telecommunications satellites. Attitude control and apogee functions of satellite propulsion systems, which make final orbit adjustments and on-orbit changes, are described, and the performance of the AJ10-181, 22 N (5-lbF) thrust reaction control thruster is examined. The thruster demonstrates a minimum steady-state performance of 285 sec, with an operational range of 27.6 to 5.2 bar feed pressure, and an excellent pulse response. Bipropellant exhaust constituents collected at various temperatures are presented, and a comparison of performance parameters is made between the AJ10-181 and representative large telecommunications satellite requirements. The thrust apogee engine of the AJ10-210, 445 N (100-lbF) is also examined, and demonstrates fast, repeatable response, smooth ignition and excellent pulse mode performance. D.L.G.

N81-22078*# International Applied Physics, Inc., Dayton, Ohio.
THE ELECTRIC RAIL GUN FOR SPACE PROPULSION Final Report, 24 Jun. 1980 - 30 Jan. 1981
D. P. BAUER, J. P. BARBER, and C. J. VAHLBERG Feb. 1981 160 p
(Contract NAS3-22475)
(NASA-CR-165312) Avail: NTIS HC A08/MF A01 CSCL 21H

An analytic feasibility investigation of an electric propulsion concept for space application is described. In this concept, quasistatic thrust due to inertial reaction to repetitively accelerated pellets by an electric rail gun is used to propel a spacecraft. The study encompasses the major subsystems required in an electric rail gun propulsion system. The mass, performance, and configuration of each subsystem are described. Based on an analytic model of the system mass and performance, the electric rail gun mission performance as a reusable orbital transfer vehicle (OTV) is analyzed and compared to a 30 cm ion thruster system (BIMOD) and a chemical propulsion system (IUS) for payloads with masses of 1150 kg and 2300 kg. For system power levels in the range from 25 kW(e) to 100 kW(e) an electric rail gun OTV is more attractive than a BIMOD system for low Earth orbit to geosynchronous orbit transfer durations in the range from 20 to 120 days. E.D.K.

N81-28139* Martin Marietta Aerospace, Denver, Colo.
LOW THRUST CHEMICAL ORBIT TO ORBIT PROPULSION SYSTEM PROPELLANT MANAGEMENT STUDY Progress Report, Sep. 1979 - Jan. 1981
R. H. DERGANCE, K. M. HAMLYN, and J. R. TEGART Jun. 1981 214 p refs
(Contract NAS3-21954)
(NASA-CR-165293; MCR-81-503) Avail: NTIS HC A10/MF A01 CSCL 21H

Low thrust chemical propulsion systems were sized for transfer of large space systems from LEO to GEO. The influence of propellant combination, tankage and insulation requirements, and propellant management techniques on the LTPS mass and volume were studied. Liquid oxygen combined with hydrogen, methane or kerosene were the propellant combinations. Thrust levels of 445, 2230, and 4450 N were combined with 1, 4 and 8 perigee burn strategies. This matrix of systems was evaluated using multilayer insulation and spray-on-foam insulation systems. Various combinations of toroidal, cylindrical with ellipsoidal domes, and ellipsoidal tank shapes were investigated. Results indicate that low thrust (445 N) and single perigee burn approaches are considerably less efficient than the higher thrust level and multiple burn strategies. A modified propellant settling approach minimized propellant residuals and decreased system complexity, in addition, the toroid/ellipsoidal tank combination was predicted to be shortest. A.R.H.

09

FLIGHT EXPERIMENTS

Includes controlled experiments requiring high vacuum and zero G environment.

A81-32435
FLIGHT EXPERIMENT TO MEASURE CONTAMINATION ENHANCEMENT BY SPACECRAFT CHARGING
D. F. HALL (Aerospace Corp., Chemistry and Physics Laboratory, Los Angeles, Calif.) In: Optics in adverse environments; Proceedings of the Seminar, Los Angeles, Calif., February 4, 5, 1980. Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1980, p. 131-137; Discussion, p. 138. USAF-supported research. refs

The ML12 experiment, launched on January 30, 1979 on the USAF Space Test Program P78-2 spacecraft, was designed to determine if spacecraft charging contributes significantly to the rate that contaminants arrive at exterior spacecraft surfaces and to establish some of the characteristics and effects of these contaminants. Two sensor types are used in the experiment: a combination retarding potential analyzer and temperature-controlled quartz crystal microbalance; and a tray of calorimetrically mounted thermal control coating samples. Preliminary results obtained with these sensors are discussed. B.J.

N81-22396*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
ZERO GRAVITY TESTING OF FLEXIBLE SOLAR ARRAYS
D. T. CHUNG and L. E. YOUNG *In its* The 15th Aerospace Mech. Symp. p 115-136 May 1981 refs Prepared in cooperation with Lockheed Missiles and Space Co., Sunnyvale, Calif.
Avail: NTIS HC A19/MF A01 CSCL 21C

Zero gravity testing in the KC-135 aircraft of flat fold flexible solar array test specimens sufficiently demonstrated the adequacy of the panel design. The aircraft flight crew provided invaluable assistance and significantly contributed to the design and development of the flexible solar array, and ultimately to the potential success of the solar electric propulsion solar array shuttle flight experiment program. E.D.K.

N81-27348*# Grumman Aerospace Corp., Bethpage, N.Y.
DEPLOYABLE ANTENNA PHASE A STUDY Final Report, 1 May 1978 - 31 Mar. 1979
J. SCHULTZ, J. BERNSTEIN, G. FISCHER, G. JACOBSON, I. KADAR, R. MARSHALL, G. PFLUGEL, and J. VALENTINE 15 May 1979 232 p refs
(Contract NAS8-32394)
(NASA-CR-164569) Avail: NTIS HC A11/MF A01 CSCL 09C

Applications for large deployable antennas were re-examined, flight demonstration objectives were defined, the flight article (antenna) was preliminarily designed, and the flight program and ground development program, including the support equipment, were defined for a proposed space transportation system flight experiment to demonstrate a large (50 to 200 meter) deployable antenna system. Tasks described include: (1) performance requirements analysis; (2) system design and definition; (3) orbital operations analysis; and (4) programmatic analysis. A.R.H.

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GENERAL

Includes either state-of-the-art or advanced technology which may apply to Large Space Systems and does not fit within the previous categories. Publications of conferences, seminars, and workshops are covered in this area.

A81-31392* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

A CASE FOR LARGE SPACE SYSTEMS TECHNOLOGY

E. K. HUCKINS, III (NASA, Langley Research Center, Large Space Systems Technology Program Office, Hampton, Va.) Society of Allied Weight Engineers, Annual Conference, 39th, St. Louis, Mo., May 12-14, 1980, 27 p. refs

(SAWE PAPER 1372)

The NASA Large Space Systems Technology (LSST) program, devoted to the development of Space Shuttle-deployable orbiting structures, is reviewed. The LSST program elements are: antennas, space platforms, assembly equipment and devices, surface sensors and control, control and stabilization, and analysis and design systems. Among the specific prospective applications for this technology base may be counted: multipurpose platforms, materials experimentation facilities, energy satellites, large optical and radio arrays, and communications platforms. O.C.

A81-33543*# National Aeronautics and Space Administration, Washington, D. C.

THE ROLE OF LARGE SPACE SYSTEMS

R. F. CARLISLE and J. D. DIBATTISTA (NASA, Washington, D.C.) American Astronautical Society and American Institute of Aeronautics and Astronautics, Annual Meeting on Space Enhancing Technological Leadership, Boston, Mass., Oct. 20-23, 1980, AAS 12 p. refs

(AAS PAPER 80-275)

Potential NASA missions utilizing large space systems are outlined. With reference to the Mobile Communications Satellite, four conceptual antenna configurations are described and compared. The Science and Applications Space Platform is described and the development of a power utilization package is examined. The package would be left on orbit and would provide a cost-effective means for collecting sunlight energy, storing it and providing power to Shuttle and payloads. S.C.S.

A81-36143

MATERIALS SCIENCES IN SPACE; PROCEEDINGS OF THE TOPICAL MEETING, BUDAPEST, HUNGARY, JUNE 2-14, 1980

A. BEWERSDORFF, (ED.) (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Institut fuer Raumsimulation, Cologne, West Germany) Meeting sponsored by COSPAR Advances in Space Research, vol. 1, no. 5, 1981. 175 p.

Studies contained in this volume focus on microgravity experiments and related ground based research aimed at a better understanding of basic phenomena that are more prominent or easier accessible to observation under space conditions. The specific subjects discussed include the effects of interfacial tension, convective, diffusional, morphological, and chemical instabilities, and mass and heat transfer at the phase boundary of solidifying liquids. V.L.

A81-36869* National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

SPACELAB UTILIZATION FOR FUTURE OPTICS TECHNOLOGY AND APPLICATIONS

C. E. DE SANCTIS (NASA, Marshall Space Flight Center, Spacelab Program Office, Huntsville, Ala.) In: Management of optics; Proceedings of the Seminar, Huntsville, Ala., October 1, 2, 1980. Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1981, p. 61-68. refs

During the timeframe from 1980 to the year 2000, optics technology and applications experiments will require spacecraft that yield the maximum benefit at minimum cost. Current NASA plans include Spacelab, Power Extension Package (PEP), 25 kW Power System (PS), and a Science Applications and Space Platform (SASP), to satisfy the user needs in low earth orbit (LEO) and geosynchronous orbit (GEO). The purpose of this paper is to acquaint the optics technology user with NASA planning applicable to his future needs. This paper identifies current NASA concepts, including Spacelab hardware, that can be utilized to achieve a broad spectrum of optics scientific and application missions. Evolving configurations of Spacelab hardware elements will be shown that can be utilized as an orbital test platform in LEO and GEO. (Author)

A81-37719

ACTIVE OPTICAL DEVICES AND APPLICATIONS; PROCEEDINGS OF THE SEMINAR, WASHINGTON, DC, APRIL 10, 11, 1980

W. J. CUNEO, JR., (ED.) (USAF, Washington, DC) Seminar sponsored by the Society of Photo-Optical Instrumentation Engineers Bellingham, WA, Society of Photo-Optical Instrumentation Engineers (SPIE Proceedings. Volume 228), 1980. 162 p $37

Studies presented in this volume focus on the technology for large adaptive optics and their potential space applications. Papers are presented on the wavefront sensors and deformable mirrors for visible wavelengths, computer-controlled optical surfacing, adaptive optics without wavefront sensors, and a perspective on large space structure control. Other papers include: a large-aperture space telescope for optical/UV astronomy, design aspects of a laser gravitational wave detector in space, and an advanced X-ray astrophysics facility. V.L.

A81-39112*# Little (Arthur D.), Inc., Cambridge, Mass.

THE USE OF A THERMAL UTILITY WITH SPACE-PLATFORM-MOUNTED INSTRUMENTS

D. W. ALMGREN, A. A. FOWLE, J. T. BARTOSZEK (Arthur D. Little, Inc., Cambridge, MA), S. OLLENDORF, and R. MCINTOSH, JR. (NASA, Goddard Space Flight Center, Greenbelt, MD) American Institute of Aeronautics and Astronautics, Thermophysics Conference, 16th, Palo Alto, CA, June 23-25, 1981, 8 p.

(AIAA PAPER 81-1114)

A thermal utility is a high-capacity heat transport system that serves as a common, temperature-controlled heat sink or source to more than one payload. The feasibility of using a thermal utility for space-platform-mounted instruments which have a range of temperature level and heat rejection requirements is examined and significant design parameters are identified. A baseline, pumped, two-phase heat transport system has been defined for NASA's proposed Space Platform, and its capability to satisfy the thermal requirements of a range of multidisciplinary instruments has been assessed. (Author)

A81-40468#

THE SPACELAB SYSTEM VERIFICATION PROGRAMME - A POWERFUL ENGINEERING-MANAGEMENT TOOL

F. B. SPERLING (ESA, Spacelab Systems Div., Noordwijk, Netherlands) ESA Bulletin, no. 26, May 1981, p. 62-69.

The Spacelab System Verification Program, developed to establish qualification procedures for Spacelab components and systems and monitor and control their completion, is discussed. The practical implementation of the verification program is described step by step, and the use of the system as a management tool at different stages of the Spacelab program is outlined. C.K.D.

A81-43601

MATERIALS 1980; PROCEEDINGS OF THE TWELFTH NATIONAL TECHNICAL CONFERENCE, SEATTLE, WA, OCTOBER 7-9, 1980

Conference sponsored by the Society for the Advancement of Material and Process Engineering. Azusa, CA, Society for the Advancement of Material and Process Engineering (National SAMPE Technical Conference Series. Volume 12), 1980. 1148 p. $60

Properties of PMR polymide composites made with improved high strength graphite fibers are considered along with the adhesion of copper plated-through-holes in printed wiring boards during thermal stress, composites as a solution to aluminum honeycomb maintenance costs, NASA service experience with composite components, high-temperature ceramic-metal attachment using a strain absorbing fiber metal pad, advances in reusable surface insulation for Space Shuttle application, and the characterization of PMR-15 polyimide resin composition in thermooxidatively exposed graphite fiber composites. Attention is given to the automatic weaving of 3D contoured preforms, the performance characteristics of hybrid structural SMC, the assessment of HV failures in potted aerospace circuits, graphite epoxy toughness studies, engineering thermoplastic block copolymers, fracture properties of elastomer-toughened epoxies, commercial composite component service experience, electrochemical deburring of printed wiring boards, high-speed machining in production, acoustic emission for quality control of Kevlar 49 filament-wound composites, and the manufacture of cost-affordable high performance titanium components for advanced air force systems. G.R.

A81-44076

GUIDANCE AND CONTROL CONFERENCE, ALBUQUERQUE, NM, AUGUST 19-21, 1981, COLLECTION OF TECHNICAL PAPERS

Conference sponsored by the American Institute of Aeronautics and Astronautics. New York, American Institute of Aeronautics and Astronautics, Inc., 1981. 544 p.
MEMBERS, $65.; NONMEMBERS, $75

The subjects considered are related to the effects of convective heat transfer on the performance of inertial systems, the improvement of aircraft specific range by periodic control, fuel optimal aircraft trajectories with fixed arrival times, effects of displacement and rate saturation on the control of statically unstable aircraft, a mode decomposition control logic for system performance enhancement, a fixed-trim re-entry guidance analysis, and maximum information trajectories for homing missiles. Attention is given to differential game guidance laws for intercept missiles, spin-controlled maneuver strategies using unbalanced precessions, synthesizing state-space models to realize given covariance functions, the analysis of aircraft longitudinal handling qualities, autopilot design via improved discrete modal control, adaptive control of flexible space structures, a Doppler aided low accuracy strapdown inertial navigation system, the reality of wheel speed modulation, a Voyager attitude control perspective on fault tolerant systems, the lower limits of seismic background noise levels, implications of improved reliability and maintainability upon digital flight control, and the attitude control of a flexible triangular truss in space. G.R.

A81-44326

MATERIAL AND PROCESS APPLICATIONS - LAND, SEA, AIR, SPACE; PROCEEDINGS OF THE TWENTY-SIXTH NATIONAL SYMPOSIUM AND EXHIBITION, LOS ANGELES, CA, APRIL 28-30, 1981

Symposium and Exhibition sponsored by the Society for the Advancement of Material and Process Engineering. Azusa, CA, Society for the Advancement of Material and Process Engineering (Science of Advanced Materials and Process Engineering Series. Volume 26), 1981. 891 p. $60

Fast curing high performance epoxy resins for filament winding applications are considered along with advanced ultrasonic testing of aerospace structures, applications of electromagnetic acoustic transducers, a new impact modified and heat resistance phenolic, a high-performance multifunctional corrosion inhibitor for aircraft, a quantitative method for photovoltaic encapsulation system optimization, applications of polymer extrusion technology to coal processing, technical applications for the personal computer, and thickness measurement methods for thin multilayer metal films. Attention is given to a multi-purpose thermoplastic polyimide, electrical characteristics of carbon/graphite fiber composites, isothermal shape rolling of titanium alloys, composite applications on Boeing commercial aircraft, the Shuttle orbiter thermal protection system, adhesive evaluation for printed wiring board bonding, the identification of nylons by pyrolysis gas chromatography, fracture and fatigue of metal-metal laminates, a comparative performance assessment of graphite and Kevlar motor cases, the challenges of manufacturing graphite-epoxy structural columns for space platforms, improved durability for weldbonded aluminum structures, maintenance and repair of advanced composite structure, composite repair concepts for depot level use, and moisture effects in epoxy adhesives. G.R.

A81-44626

SPACE - ENHANCING TECHNOLOGICAL LEADERSHIP; PROCEEDINGS OF THE TWENTY-SEVENTH ANNUAL MEETING, BOSTON, MA, OCTOBER 20-23, 1980

L. P. GREENE, (ED.) (U.S. Department of Transportation, Transportation Systems Center, Cambridge, MA) Conference sponsored by AAS, AIAA, Avco Corp., et al San Diego, CA, American Astronautical Society; Univelt, Inc., 1981. 627 p. $65

Papers on systems and technology research are presented, and include such general topics as communication and navigation, solar energy, meteorology, earth resources, materials processing in space, space transportation, and defense applications. Special attention is given to the NAVSTAR Global Positioning System, space manufacturing for the Solar Power Satellites, bridge and spider-web type structures in space, and the Space Shuttle. K.S.

A81-45502

JOINT AUTOMATIC CONTROL CONFERENCE, SAN FRANCISCO, CA, AUGUST 13-15, 1980, PROCEEDINGS. VOLUMES 1 & 2

Conference sponsored by AIChE, ASME, IEEE, and ISA. New York, Institute of Electrical and Electronics Engineers, Inc., 1980. Vol. 1, 831 p.; vol. 2, 741 p.
MEMBERS, $56.25; NONMEMBERS, $75

Topics discussed include decentralized control, efficiency energy use through control, adaptive control, dynamic modeling of chemical processes, advanced control technology for machine tool systems, frequency domain techniques for multivariable control systems, advanced methods for designing aircraft flight control systems, digital signal processing hardware and architecture, the optimization of control systems, and the modeling and simulation of large systems. Also considered are the control and maneuvering of V/STOL aircraft, the modeling and control of waste-water treatment processes, instrumentation and computer process control, fluid power control, system identification for large space structures, turbine engine control, automation and robotics, advances in fuzzy logics and fuzzy control, and control applications in electric and solar energy systems. B.J.

A81-47490
THE RESEARCH OF SPACE THERMAL SIMULATION TESTING METHODS FOR FUTURE LARGE SPACECRAFT
G.-R. MIN and J.-G. HU (Academy of Space Technology, Beijing, People's Republic of China) International Astronautical Federation, International Astronautical Congress, 32nd, Rome, Italy, Sept. 6-12, 1981, 11 p. refs
(IAF PAPER 81-384)

The cost of thermal vacuum testing with solar simulators, and existing ground facilities which cannot hold large spacecraft are discussed, and various approaches towards solving these problems are proposed. Difficulties encountered with thermal simulation testing include long testing periods and small vacuum chambers. A space flux simulator with an extra infrared heater is proposed, which costs less than the solar simulator, requires less space in the vacuum chamber, and produces satisfactory results. Segmental simulation testing is conducted, which divides the spacecraft into a number of smaller parts, and performs the testing separately, thus requiring a smaller vacuum chamber. Unsteady thermal balance testing is also conducted, which can reduce the cost of development and shorten the test periods 3 to 4 times with an accuracy of + or - 2 C. Finally, important principles in thermal design are discussed. D.L.G.

N81-22076*# Vought Astronautics, Dallas, Tex.
STUDY OF THERMAL CONTROL SYSTEMS FOR ORBITING POWER SYSTEMS Final Report
H. R. HOWELL 16 Feb. 1981 168 p refs
(Contract NAS8-33560)
(NASA-CR-161751; REPT-2-53020/IR-52666) Avail: NTIS HC A08/MF A01 CSCL 22B

Thermal control system designs were evaluated for the 25 kW power system. Factors considered include long operating life, high reliability, and meteoroid hazards to the space radiator. Based on a cost advantage, the bumpered pumped fluid radiator is recommended for the initial 25 kW power system and intermediate versions up to 50 kW. For advanced power systems with heat rejection rates above 50 kW the lower weight of the advanced heat pipe radiator offsets the higher cost and this design is recommended. The power system payloads heat rejection allocations studies show that a centralized heat rejection system is the most weight and cost effective approach. The thermal interface between the power system and the payloads was addressed and a concept for a contact heat exchanger that eliminates fluid transfer between the power system and the payloads was developed. Finally, a preliminary design of the thermal control system, with emphasis on the radiator and radiator deployment mechanism, is presented. J.M.S.

N81-22308*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
THE 15TH AEROSPACE MECHANISMS SYMPOSIUM
1981 433 p refs Symp. held in Huntsville, Ala., 14-15 May 1981; sponsored in part by California Inst. of Technology and Lockheed Missiles and Space Co., Inc.
(NASA-CP-2181) Avail: NTIS HC A19/MF A01 CSCL 20K

Technological areas covered include: aerospace propulsion; aerodynamic devices; crew safety; space vehicle control; spacecraft deployment, positioning, and pointing; deployable antennas/reflectors; and large space structures. Devices for payload deployment, payload retention, and crew extravehicular activities on the space shuttle orbiter are also described.

N81-26166*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
STRUCTURAL DYNAMICS AND CONTROL OF LARGE SPACE STRUCTURES
E. B. LIGHTNER, comp. Jun. 1981 136 p refs Proc. held at Hampton, Va., 30-31 Oct. 1980
(NASA-CP-2187; L-14609) Avail: NTIS HC A07/MF A01 CSCL 22B

The focus of the workshop was the basic research program assembled by LaRC to address the fundamental technology deficiencies that were identified in several studies on large space systems (LSS) conducted by NASA in the last several years. The staffs of the respective participants were assembled at the workshop to review the current state of research in the control technology for large structural systems and to plan the efforts that would be pursued by their respective organizations. T.M.

N81-27158# Centre National d'Etudes Spatiales, Toulouse (France).
TECHNOLOGIES USED IN THERMAL CONTROL OF SATELLITES, SONDES AND SPACEBORNE EXPERIMENTS [TECHNOLOGIES UTILISEES POUR LE CONTROLE THERMIQUE DES SATELLITES, DES SONDES ET DES EXPERIENCES EMBARQUEES]
I. ALET, J. C. GUILLAUMON, and B. TATRY *In its* Thermal Control of Spaceborne Expts. p 57-84 1981 In FRENCH
Avail: NTIS HC A07/MF A01

An assortment of design solutions to temperature control problems encountered in an aerospace environment were reviewed. Spacecraft thermal control, using either thermo-optical coatings, insulators, heat conductors, or thermoregulation components, is considered. Fluid heat flow devices, radiators, hinged shielding, and applications of phase change materials are also discussed. Cooling techniques are enumerated and explained. Particular difficulties arising when furnaces are used in space are brought up. As an example of a complex temperature control system, the Spacelab thermal control circuit is shown. Author (ESA)

N81-27169*# Systems Science and Software, La Jolla, Calif.
ANALYSIS OF THE CHARGING OF THE SCATHA (P78-2) SATELLITE Final Report, Mar. 1979 - Oct. 1980
P. R. STANNARD, I. KATZ, M. J. MANDELL, J. J. CASSIDY, D. E. PARKS, M. ROTENBERG, and P. G. STEEN Dec. 1980 249 p refs Sponsored in cooperation with AFGL
(Contract NAS3-21762)
(NASA-CR-165348; SSS-R-81-4798) Avail: NTIS HC A11/MF A01 CSCL 22B

The charging of a large object in polar Earth orbit was investigated in order to obtain a preliminary indication of the response of the shuttle orbiter to such an environment. Two NASCAP (NASA Charging Analyzer Program) models of SCATHA (Satellite Charging at High Altitudes) were used in simulations of charging events. The properties of the satellite's constituent materials were compiled and representations of the experimentally observed plasma spectra were constructed. Actual charging events, as well as those using test environments, were simulated. Numerical models for the simulation of particle emitters and detectors were used to analyze the operation of these devices onboard SCATHA. The effect of highly charged surface regions on the charging conductivity within a photosheath was used to interpret results from the onboard electric field experiment. Shadowing calculations were carried out for the satellite and a table of effective illuminated areas was compiled. J.D.H.

N81-29147*# Vought Corp., Dallas, Tex.
STUDY OF THERMAL MANAGEMENT FOR SPACE PLATFORM APPLICATIONS: UNMANNED MODULAR THERMAL MANAGEMENT AND RADIATOR TECHNOLOGIES
J. A. OREN May 1981 114 p refs
(Contract NAS3-22270)
(NASA-CR-165307; REPT-2-53020/1R-52778) Avail: NTIS HC A06/MF A01 CSCL 22B

Candidate techniques for thermal management of unmanned modules docked to a large 250 kW platform were evaluated. Both automatically deployed and space constructed radiator systems were studied to identify characteristics and potential problems. Radiator coating requirements and current state-of-the-art were identified. An assessment of the technology needs was made and advancements were recommended. A.R.H.

N81-29479*# Alabama Univ. in Huntsville. School of Science and Engineering.
UAH/NASA WORKSHOP ON THE USES OF A TETHERED SATELLITE SYSTEM
S. T. WU, ed. May 1978 235 p refs Presented in Huntsville, Ala., 2-3 May 1978
(Contract NAS8-30563)
(NASA-CR-161836) Avail: NTIS HC A11/MF A01 CSCL 08G

Potential applications of the system are categorized into four areas: geological applications, atmospheric applications, electrodynamics and plasma studies, and technology applications. The multiple-use tethered system with feedback control, will be capable of supporting a payload or satellite suspended from the Shuttle cargo bay, at distances up to 100 kilometers from the Shuttle. Experiments proposed include: geomagnetic mapping, lower atmospheric measurements, ionospheric interactions with large space structures, solar wind transport, and magnetohydrodynamic measurements.

N81-31243# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Cologne (West Germany).
PROJECTS AND PLANS OF THE GERMAN PROGRAM ON MATERIALS RESEARCH AND PROCESSING TECHNOLOGY IN SPACE [PROJEKTE UND VORHABEN DES DEUTSCHEN PROGRAMMS: WERKSTOFFORSCHUNG UND VERFAHRENSTECHNIK IM WELTRAUM]
H. S. ANTON and N. KIEHNE *In* DGLR Spacelab Utilization: Mater. Res. and Processing Technol. in Space p 21-35 1980 refs In GERMAN
Avail: NTIS HC A16/MF A01

The status and preliminary results of various German projects that are either planned or under way are discussed: (1) materials laboratory for the first Spacelab mission; (2) technological experiments under zero gravity (TEXUS); (3) materials science autonomous experiments under zero gravity (MAUS); (4) the shuttle pallet satellite project (SPAS), defining a family of space platforms; and (5) D1-mission, an all German flight for chemical, physical and biomedical applications. Individual experimental designs are considered and the payload configurations of the different projects are shown. A comparison of the German program and its financial implications with that of other organizations or countries is appended. Author (ESA)

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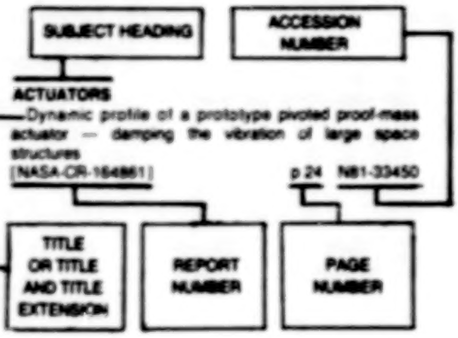
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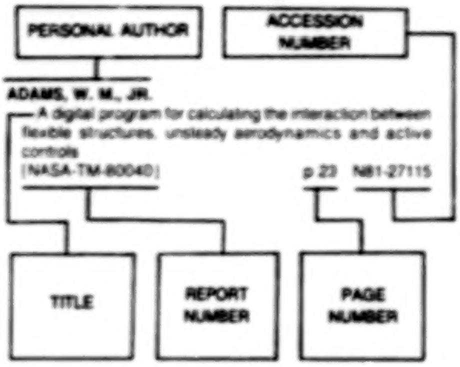
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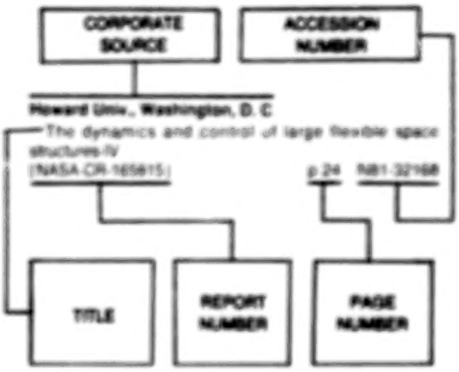
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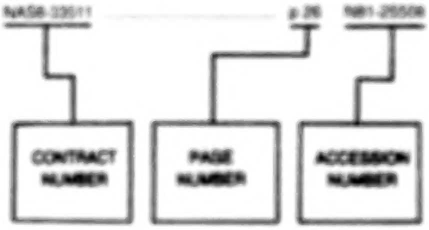

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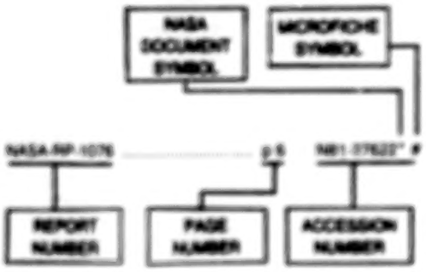

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16. Abstract

This bibliography lists 220 reports, articles and other documents introduced into the NASA scientific and technical information system between July 1, 1981 and December 31, 1981. Its purpose is to provide helpful information to the researcher, manager, and designer in technology development and mission design in the area of the Large Space Systems Technology (LSST) Program. Subject matter is grouped according to systems, interactive analysis and design, structural concepts, control systems, electronics, advanced materials, assembly concepts, propulsion, solar power satellite systems, and flight experiments.

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